# KNOWLEDGE-BASED PLATFORM FOR THE PROVISIONING SYSTEM

By

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## Dedication

This paper is dedicated to Siti Hajar Mohamed and all my lovely children; Mohammed Hafiz, Mohammed Hakim, Nur Dania and Nur Madiha.

- Shahrulnizam b Noor Ibrahim

**Abstract**

Abstract of project paper II to the Senate of Open University Malaysia in fulfillment of the requirement to the degree of Masters in Information Technology.

**KNOWLEDGE-BASED PLATFORM FOR PROVISIONING SYSTEM**

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Supervisor : Associate Professor Dr Jamilin Jais

The study examined the effectiveness and application of the tacit knowledge in the area of service delivery and order provisioning. The selected organization for this study is a corporate telecommunication body namely Telekom Malaysia Bhd (TM) and their specific customer called Government Integrated Telecommunication Network (GITN). The study was conducted on the chosen domain and organizations due to the special business arrangement which is based on wholesale approach between TM and GITN. It is noted that the current Order Management System (OMS) in TM is inefficient to provide the required analysis and real-time status reports of the service delivery due to its poor handling of bulk service orders. The real-time analysis and service delivery reports in relation to service provisioning are vital drivers to TM management for the decision making process.

It is the key objective of this study to propose a solution to improve TM current business process particularly in the area of tracking and monitoring. The approach proposed in this study is to make use of the tacit knowledge acquired from the experts at ground level. In the process of leveraging the underlying tacit knowledge in TM day-to-day business process, the study requires the process of elicitation, adoption of effective interview technique, codification of tacit knowledge into explicit knowledge and building up appropriate system rules for the prototype. In general, the results have shown an acceptable improvement especially in the project management of service delivery area. The findings of this study are sufficient to encourage further work on the research model. Several recommendations are presented for future research.

## Abstrak

Abstrak dokumen projek II yang dikemukakan kepada Senat Open University Malaysia sebagai memenuhi keperluan untuk ijazah Masters in Information Technology

**KNOWLEDGE-BASED PLATFORM FOR PROVISIONING SYSTEM**

Oleh
SHARULNIZAM B. NOOR IBRAHIM

Mei 2008

Penyelia : Associate Professor Dr Jamilin Jais

Kajian ini mengenal pasti keberkesanan dan pengunaan 'tacit knowledge' di dalam pengurusan 'service delivery and order provisioning'. Organisasi yang dipilih untuk kajian ini ialah badan korporat telekomunikasi iaitu Telekom Malaysia Bhd (TM) dan penggunanya iaitu Government Integrated Telecommunication Network (GITN). Ia dipilih kerana asas pengurusan perniagaan antara badan-badan tersebut adalah berdasarkan 'wholesale approach' iaitu permintaan dan pengurusan servis adalah secara pukal. Telah dikenal pasti bahawa sistem 'Order Management System (OMS)' di TM tidak dapat membantu pihak pengurusan projek secara terperinci dan bermanafaat terutamanya di dalam bidang pemantauan dan pengurusan projek lebih-lebih lagi dalam menghasilkan analisis terkini dan repot mengenai status servis pukal yang diberikan kepada pihak GITN. Analisis serta repot yang dihasilkan oleh pihak pengurusan projek adalah faktor terpenting untuk pihak pengurusan atasan membuat keputusan strategik berkenaan projek itu terutamanya yang melibatkan kewangan syarikat.

Berdasarkan keperluan inilah, kajian ini dijalankan untuk menghasilkan cadangan yang berguna dalam menjadikan proses perniagaan TM lebih efisien terutamanya di dalam bidang pemantauan dan pengurusan servis secara pukal. Asas teknik kajian ini adalah ingin melaksanakan penggunaan 'tacit knowledge' di dalam kerja seharian dan mengubahnya ke dalam penggunaan sistem oleh pekerja-pekerja TM. Dalam mencapai objektif ini, kajian ini akan mengambil kira teknik 'elicitation', interview, 'codification of tacit knowledge into explicit knowledge' dan membangunkan sistem berasaskan pengetahuan ini. Secara kasar, kajian ini telah berjaya menjadikan proses seharian di TM terutamanya berkenaan pemantauan dan pengurusan servis lebih efisien dan berstruktur. Hasil serta keputusan daripada kajian ini adalah mencukupi untuk melaksanakan kajian-kajian lain di masa hadapan. Di samping itu juga, penulis telah memberikan beberapa cadangan kajian lain berdasarkan hasil kajian ini.

**Acknowledgements**

I would like to express my gratitude and sincere appreciation to my Masters project advisor, Prof Associate Dr Jamilin Jais for helping me and giving direction in order for me to complete this entire study. I thank him for his guidance and patience with my many errors and especially for the speed in which he delivered the feedback throughout this iterative process and his willingness to spend his time helping me to resolve my study challenges.

I would like to thank all the staff of Open University Malaysia (OUM) who made my fulfillment towards Masters Degree a rewarding and fulfilling experience. I hope with the assistance of dedicated OUM staff, the institution will continue to grow in stature and recognition for academic excellence.

Finally, my warmest and deepest love and appreciation to my parents and my lovely children who have patiently assist me achieving completing this journey and enabled me to have a life of opportunity and adventure that far exceeded my expectations.

**Approval**

## PROJECT PAPER/ CASE STUDY SUBMISSION FORM

Name of Student: SHARULNIZAM B. NOOR IBRAHIM
Matriculation No.: CGS00020403

Director
Centre for Graduate Studies
Open University Malaysia

Dear Sir,

Attached are the following documents for your evaluation and examination.

(I) Chapter 1: Introduction
(II) Chapter 2: Literature Review
(III) Chapter 3: Research Methodology
(IV) Chapter 4: System Implementation and Results
(V) Chapter 5: Discussion and Recommendations
(VI) Chapter 6: Conclusions

I have thoroughly checked my work and I am confident that it is free from major grammatical errors, weaknesses in sentence constructions, spelling mistakes, referencing mistakes and others. I have checked with CGS Guideline for Writing Project Papers and I am satisfied that my project paper proposal satisfies most of its requirements.

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**Supervisor's Signature:**

.....

Assoc. Prof. Dr. Jamilin Jais
Program Coordinator
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**Declaration Form**

# DECLARATION

Name : SHARULNIZAM B. NOOR IBRAHIM
Matric. Number : CGS00020403

I hereby declare that this project paper is the result of my own work, except for quotations and summaries which have been duly acknowledged.

Signature: _____ Date: 7/5/2008

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## List of Abbreviations / Notations / Glossary of Terms

| Abbreviations | Descriptions |
|---|---|
| CAN | Customer Access Network. They are one of the divisions in TM that are responsible in planning and developing the network infrastructure consisting of copper and fibre telecommunication network. |
| CASS | Customer Automated Support System. It is one of the key OMS used by TM employees for the management of the order delivery to the customers. The system is based on the mainframe technology. |
| CNO | Customer Network Operation. They are one of the operational divisions in TM that is responsible in the installation of the leased line modems and performs the local end testing at the customer end premise. |
| COINS | Corporate Information Superhighway Networks. One of TM divisions and are responsible in the overall configuration of the Internet Protocol (IP) network imposed on the leased line services by Telekom Malaysia. They are also responsible in ensuring that Telekom Malaysia network can be linked seamlessly with GITN's network. Services under them are mainly Frame Relay and IPVPN technology. |
| FM | Formal Method is one in which the elicitator stresses on conducting the requirement in a formalilty like during the elicitation stage. |
| GITN | Government Integrated Telecommunication Network. A company that serves departmental governments nationwide as part of their inspiration to build up Electronic Government infrastructure. They are currently served by TM as wholesale customers |
| KA | Knowledge Acquisition is "the process of extracting domain-specific problem solving expertise from a knowledge source and representing in a machine manipulation form" (Agarwal & Tanniru, 1990). |
| LSS | Leased Services Support. They are one of the TM divisions that are responsible for the planning and development of the MLCN network nationwide. |
| MLCN | Managed Leased Circuit Network. One of TM divisions; this group is responsible in performing the end-to-end testing and the configuration of the leased line. They are the one gives instruction to the employees at the ground (CNO) on how to trouble shoot the problem. |
| OMS | Order Management System is a common term used in corporate body such as Telekom Malaysia that refers to the system or software that stores details about the service orders pertaining to the services requested by the customers and keeps the information on the status of the service provisioning. |
| TM | Telekom Malaysia Bhd. A telecommunication company in Malaysia that offers telecommunication services |

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# 1.0 Introduction

## 1.1. Problem Statement and Goal

Poor elicitation process during system requirement stage of Order Management System (OMS) in corporate bodies has resulted in inefficient and poor business process of the companies. This elicitation process is essential to ensure that the complete developed OMS is able to resolve any related provisioning problems inclusive of monitoring and tracking requirement.

The context of this paper concerns with the investigation of the effectiveness and application of the tacit knowledge in the specific problem domain and translate them into key usable explicit knowledge. The acquired explicit knowledge will be converted into more defined business rules and embedded into a knowledge-based system specifically to enhance the efficiency of the business process in the related domain. The domain of research is chosen from one of the most critical business area in Telekom Malaysia (TM) which is service order provisioning and how TM personnel monitor and track the service orders as part of their commitment to deliver the service to the customers. The related TM customer in the chosen domain of research is Government Integrated Telecommunication Network (GITN). They are selected due to the special business arrangement between TM and GITN where the service orders handled are in bulk and the required service delivery time is short

therefore requires special attention from both parties. In the process of translating the tacit knowledge into explicit knowledge and leverage them in TM day-to-day service provisioning business process in a form of knowledge-based system, the study greatly deals with the elicitation of system requirement process, chosen effective interviewing technique and codification process.

As an outcome of conducting the research, the goal is to develop a prototype which is based on a knowledge-based foundation and its key function is to be able to provide solutions to problem in the particular domain specifically in monitoring and tracking of the TM service orders.

## 1.2. Background

Order Management System (OMS) is a common term used in corporate body such as Telekom Malaysia that refers to the system or software that stores details about the service orders pertaining to the services requested by the customers and keeps the information on the status of the service provisioning. The service provisioning details include the info at the point when the customers request the service until the service is ready to be used by the customers. In the process of delivering the required service to the customer, OMS facilitates the assignment of the available network inventory that refers to the physical network infrastructure at ground and all info are recorded in the service orders. The service orders can be

monitored and tracked during the provisioning stage until the service can be offered by the customer. Apart from capturing the service provisioning details, OMS is also responsible to capture the customer profile information and the account level information. This info can be used to facilitate the process of customer credit verification or checking the payment history for validity purposes prior to the service order processing. Among crucial task during the service order processing are to prioritise the service order and establish reasonable delivery dates. The delivery date is one in which the service provider, namely Telekom Malaysia determines and guarantees the customer to offer the requested service based on the available infrastructure at ground and the time taken to deliver the service.

It is common that as demand on services increases, OMS stores more service order info in the system inventory. As service orders are stored, more advanced and better methods are needed to establish in order to monitor and track the huge amount of service orders in the OMS. It has somehow become pertinent that common reports produced by OMS are not able to handle the monitoring and tracking requirement of bulk service orders. It is worse when the customer requires the services fast with short delivery period.

In this paper, the research focuses on system requirement in relation to developing a system prototype as an addition to existing Telekom Malaysia OMS in order to support monitoring and tracking needs. It is noted that system requirement stage is vital as part of the system development process and existing OMS has failed to fulfill the requirement of monitoring and tracking. Failure of existing OMS in terms of producing the desired reports and analysis for monitoring and tracking purposes results in a workaround solution by the project team to produce the desired info from various sources of systems available in Telekom Malaysia. Inefficient techniques of monitoring and tracking the progress of service orders can cause companies including Telekom Malaysia to miss tremendous opportunities for improved profitability.

It is noted that a single OMS in TM is not able to cater the entire service order provisioning. Due to this reason, there are few OMS in operation in TM in order to support the end-to-end service provisioning. This has resulted in inevitable fragmented business process in TM in the area of fulfillment and assurance. TM project managers need to refer few OMS in order to monitor and track the actual progress status of the service orders. This is the key area where the proposed prototype is expected to be able to handle and resolve the problem.

GITN Sdn Bhd is on of the major wholesale customers served by Telekom Malaysia. Amongst its purpose are to develop an integrated telecommunication infrastructure to support all governmental ministries and agencies and its primary vision is to be as a one stop centre for IT solution as well as the IT integrator for the government. One of the key initiatives conducted by GITN is to implement the electronic government (e-government) concept.

E-government or known as EG*Net is intended to create a citizen-centric Government by ensuring all agencies, which from different components of Government, work for the benefit of the general public. By implementing e-government, it will improve the communication links amongst government agencies and consequently will enhance transparency and exchange of information as well as collaboration within the government sector, thus reducing the red-tapes and bureaucracy between the public and the government.

As a network provider; GITN plays an important role in providing a reliable and efficient communications network. GITN provides managed network connectivity and managed security services to all government agencies that are implementing the e-Government application nationwide. GITN also provides integrated network connectivity for intranet, Extranet and Internet access. With single connectivity to the GITN node, an agency Intranet can communicate with other agency Intranets as well as to

EG*Net by using the same infrastructure. The network has built-in connectivity to the Internet gateway provider, enabling electronic communications between Government-to-Government, Government-to-Business and Government-to-Citizens networks.

In order to support this highly visionary idea, GITN has worked together with Telekom Malaysia to build up a nationwide telecommunication network that will interconnect all governmental ministries and agencies together. Currently, there are more than 7,000 orders issued by GITN to Telekom Malaysia where each order represents the request to set up one link or leased line between two governmental agencies. The orders are gradually increased as more requests are done. All of the requested orders must be delivered to GITN within the agreed time. A typical delivery time for a single order of a leased line normally takes less than a fortnight. However, since the requests are in bulk and they must be completed with a short time, a proper task force has been set up in order to project manage the whole service delivery activities and meet the datelines. Imagine how much work involved here in order to deliver 7,000 GITN orders and most of them are in manual processes.

Major operational problems encountered during the provisioning stage are summarized as follows;

1. The task force encounters a lot of problem in managing the order provision due to limited capabilities of existing OMS or known as

Customer Automated Support System (CASS). CASS is unable to provide them the summary reports and analysis of the current status.

2. Coordination / project manage of many divisions in order to deliver the service is poor due to lack of IT tool to support the business activities and failure in controlling multi-divisional employees. Many divisions are involved in the GITN order provisioning and they are as follows:

    a. Customer Network Operation (CNO): This group is responsible in the installation of the leased line modems and performs the local end testing at the customer end premise. They constantly work together with the MLCN group during the end-to-end testing.

    b. Customer Access Network (CAN): this group is responsible in planning and developing the network infrastructure consisting of copper and fibre telecommunication network.

    c. Managed Leased Circuit Network (MLCN): this group is responsible in performing the end-to-end testing and the configuration of the leased line. They are the one gives instruction to the employees at the ground (CNO) on how to trouble shoot the problem.

d. GITN: as the customer to Telekom Malaysia, they are responsible in installing the router at their customers' premises. They will perform their tasks immediately after Telekom Malaysia has successfully handed over the leased line service to them. Their routers will be linked to Telekom Malaysia's leased line modems.

e. Sales and Marketing group: They work closely with GITN to ensure that the end customers (government ministries or agencies) are available during installation and all internal wiring has been installed prior to the leased line installation.

f. Corporate Information Superhighway (COINS): They are responsible in the overall configuration of the Internet Protocol (IP) network imposed on the leased line services by Telekom Malaysia. They are also responsible in ensuring that Telekom Malaysia network can be linked seamlessly with GITN's network.

3. Task force is poor at reporting the in-depth current status of the delivery to the management every week. Typically the status of reports presented are one week behind, thus provides no significant values in decision making by the upper management.

4. Task force conducts frequent meetings with relevant multi-divisional employees when they encounter complex problems. Some

complicated and rare problems cannot be handled by one single division and might require stages of meetings to solve it. In the event that they successfully resolve the problems, there is no system to capture and store the experience they have gone through, so that in the future others can take benefits from them if similar problems are encountered.

5. Traditional method of meeting during the project management is an ineffective tool in solving the provisioning problems. Handling problems via meetings prone to excessive and unnecessary meeting that give impact to the followings:

    a. Delaying the delivery process and increase time to complete the task.

    b. More meetings mean more un-necessary budget

    c. Same experts need to participate every time similar problem occurs. By having a knowledge-based system, other non-expert or normal employee who has not come across the similar problem can still make judgments based on the experts' experience.

    d. Current working environment does not promote efficiency and effectiveness to the experts. Experts should focus on more benefiting activities rather than attending similar meetings, thus

avoid wasting time on repeated processes, such as involvement in the preventive measures rather than reactive ones.

## 2.0 Literature Review

In the first stage of understanding the overall problem domain, this paper concerns in a great deal with the elicitation phase of the system requirement process in order to capture the required tacit knowledge. The codified format of tacit knowledge will be later used as a basis to develop a foundation of a knowledge-based prototype. The system rules of the prototype are formulated from the codified tacit knowledge with a key objective in mind to be able to support and enhance the efficiency of the business process particularly in the area of tracking and monitoring. Elicitation during the system requirement stage involves using one or more techniques to determine the needs of users so that the systems can be built that meet those needs (Hickey & Davis, 2003). Elicitation and documenting quality requirements represents a critical success factor within the software engineering lifecycle. Throughout the software engineering literature, poor requirements are continuously cited as a reason for project failure (Summer, 2000).

Whitehead (2001) offers a pragmatic assessment:

> If you don't do a good job of capturing the requirements, the requirements are still there – you just don't know about them. So you are likely to produce a product that the customers do not want, and then have to do more (unplanned)

work to put things right when the customers complain. This is not a sensible way to go about developing a product (p. 182).

Consider the current and historical data:

- Poor requirements management can constitute to 71% of software projects fail; greater than bad technology, missed deadlines and change management issues (Lindquist, 2005)
- Incomplete requirement accounts for 12.3% of projects that are cancelled; the second largest single reason (Grunbacher & Briggs, 2001)
- Boehm (1981) estimated that corrections made to requirements later in the development process could cost up to 200 times as much as correcting during the analysis phase.
- Bell and Thayer (1976) noted that poor requirement had a critical impact on software quality

Many techniques have been developed for requirement elicitation. As an example of the common methods accessible, Maiden and Rugg (1996) present the acquisition of requirement (ACRE) framework of 12 elicitation techniques (Table 1)

Table 1 : Acquisition of Requirement Techniques

| | |
|---|---|
| o Observation | o Brainstorming |
| o Unstructured interviews | o Rapid prototyping |
| o Structured interview | o Scenario analysis |
| o Protocol Analysis | o RAD workshops |
| o Card Sorting | o Ethnographic method |
| o Laddering | o Repertory grids |

The key objective to conduct a proper requirement elicitation phase is to acquire the tacit knowledge from the experts of the chosen domain. Bush and Richards (2000) had defined tacit knowledge as the set of actions and experiences that through careful usage of tools and methodologies may largely be expressed and transferred from one individual to the next (p. 2)

Nonaka and Takeuchi (1995) describe tacit knowledge as "personal knowledge embedded in individual experience and involves intangible factors such as personal belief, perspective and value system". Wright and Ayton (1987) call this knowledge as "rule of thumb". Tacit knowledge presents the paradox of expertise (Johnson, 1983). This is where an expert accumulates more and more knowledge to carry out a task to point where they also lose awareness of what they know. From an economics perspective, Friedrich Hayek referred tacit knowledge as the unwritten and informally expressed stock of expertise within an organization that may be essential to its effective operation (Stenberg & Horvath, 1999).

As oppose to tacit knowledge, explicit knowledge is perceived as knowledge that can be articulated in formal language or documented, where else, tacit knowledge is personal knowledge, embedded in individual experiences, beliefs, perspectives and values. Explicit knowledge may be used and protected as the intellectual property of a community and would further stimulate the generation of new knowledge. Casselman and Samson (2005) describe explicit knowledge as information about facts and theories.

Reichental (2006) describes explicit knowledge as precise, clearly expressed or readily observable. Where else, tacit knowledge deals with the complexity of intangibles. Reichental also listed down the requirement of sources for both tacit and explicit knowledge as illustrated in Table 2 below. The table 3 explains the key differences between the tacit and explicit knowledge.

Table 2 : Examples of Explicit and Tacit Requirement sources

| Tacit Knowledge | Explicit Knowledge |
|---|---|
| Rule of thumb | Manuals |
| Tricks of the trade | Forms |
| Workarounds | Standard operating procedures |
| Undocumented processes | Instructions |
| "Gut Feel" | Task lists |
| Know-how | Workflow diagrams |
| Expertise | Observational Video |
| Intuition | Policies |

Table 3 : Key differences between Explicit and Tacit knowledge

| Tacit Knowledge (Subjective) | Explicit Knowledge (Objective) |
|---|---|
| Knowledge of experience (body) | Knowledge or rationality (mind) |
| Simultaneous knowledge (here and now) | Sequential knowledge (there and then) |
| Analog knowledge (practice) | Digital knowledge (theory) |

The goal of elicitation process is to acquire the knowledge. The researcher requires the most accurate information in order to deliver the solution that best meets the requirement of an organization. The most challenging organizational knowledge lies in those cases where its existence is not explicit; also known as tacit knowledge. It is central challenge for organizations to take advantage of individual's tacit knowledge (Surowiecki, 2004). Recognising the existence and

constraints of tacit knowledge in the system development process is necessary for the advancement of knowledge engineering (Berry, 1987). Byrd et al. (1992) states that in the system development process, the requirement analysis phase is the most critical stage. Fellers (1987) stresses the importance of this stage as the least understood yet the most important process. Byrd et al. suggests that "it is distressing perhaps even shocking that so little evaluation research has been undertaken on elicitation techniques". Wynekoop and Russo (1995) make the point that much research has been done on new approaches, while little emphasis has been placed on existing methodologies. They maintain without sufficient knowledge of existing processes, new approaches may be irrelevant and unsound. This sentiment is echoed by Glass (2004) who challenges researchers to focus on validating overall usefulness and identifying when current methodologies are best employed. Lamsweerde (2000) recommends for future research that while a body of knowledge exists in the software and environment in the requirement phase, considerable work is required in the area of human side of requirement engineering.

The science of tacit knowledge has its roots in work done by Polanyi (1967). He held that knowledge can be a collection of for example; informed guesses or hunches, what he termed as "passions". He contended that knowledge discovery must be conducted in the context of the fact that "we can know more than we can tell".

In order to evaluate the effectiveness of the elicitation technique in acquiring the knowledge, Reichental (2006) describes that there are two key factors determining the effectiveness of interview as part of elicitation. Those are the structure and the specificity of the interview. As such he added that the interview can be mapped into four quadrants differentiated by the degree levels of structure and the specificity. The four quadrant model argues that the effectiveness in eliciting tacit knowledge is a function of the degree of structure and specificity of the interview technique utilized. Apart from the characteristics of the technique itself, effectiveness will also depend on the task environment – specifically requirement complexity and the human factors. Structure is something arranged in a definition pattern of organization (Merriam-Webster Dictionary, 2005). Reichental describes structure as a term that refers to the degree in which the construction and organization of the interview facilitates meeting the interview objectives. Where else the specificity is a term refers to the degree to which the approach impacts the level of ambiguity in what is asked and how it is asked. As the continuum moves from less to more specificity, questions result in a greater accuracy of answers; conversely they may reduce the wider context and holistic view of the answer.

Many researches have been conducted to understand the effectiveness of elicitation techniques during the requirement phase. Table 4 below listed down the popular elicitation techniques and their definition.

Table 4 : Popular elicitation techniques

| Techniques | Descriptions |
|---|---|
| Interviewing | A variety of methods that involve questions being asked to an individual or group and the capture responses (Agarwal & Tanniru, 1990) |
| Observing | The act of viewing and capturing the process and person executing a task or activity (Byrd, Cossick & Zmud, 1992) |
| Protocol Analysis | Involves observing an individual perform a task while the person concurrently explains out loud their thought processes (Berry, 1987) |
| Repertory Grid Analysis | Process of capturing and analyzing a person's rating of objects and the comparison of those objects to one another in a particular domain (Hart, 1985) |
| Brainstorming | Group activity that generates ideas or exposes more knowledge by listing all participants thought and conducted in a free-form manner with few constraints (Liou, 1992) |
| Group Support System (GSS) | Uses information and communication technology (ICT) to facilitate group participation in the capture of knowledge (Liou, 1992) |

Although, there are plenty of techniques to acquire the tacit knowledge in the specific domain, the author shall select the interview as the only technique for the elicitation process. As the main goal and the scope of the research is to capture the required tacit knowledge and develop a foundation of a knowledge-based platform for a prototype. The evaluation of effectiveness of available elicitation techniques is out of the scope of this research.

Interviewing is cited as the most popular requirement elicitation method (Hart, 1985; Fellers, 1987; Grabowski, 1988; Liou, 1992; Purvis & Sambamurthy, 1997; Rogich & Browne, 1998). Bystrom and Jarvelin (1995) maintain that

interviewing provides more opportunity for thorough analysis. Agarwal and Tanniru (1990) maintain that the interview is conceptually simple for the knowledge engineer and expert to comprehend. It is familiar task. They continue to conjecture that interview techniques by their popularity suggest that a knowledge engineer's skills in interviewing become a significant factor in determining the completeness, accuracy and reliability of the elicited information. Table 5lists the main reasons each researcher attributes to the reason for the popularity of interview techniques.

Table 5: Reasons for Popularity of Interviewing Technique

| Reasons | Authors |
|---|---|
| Skill level.<br>Necessity for subject matter expertise | Hickey and Davis (2003) |
| The human factor | Holtzblatt and Beyer (1995); Saiedian and Dale (2000) |
| Simplicity | Diaper (1989); Agarwal and Tanniru (1990) |
| Eliciting unanticipated information | Liou (1992) |
| Familiar and unnatural | Agarwal and Tanniru (1990) |
| Historical success in other social sciences | Goguen and Linde (1993) |
| Better possibilities for thorough analysis | Bystrom and Jarvelin (1995) |
| Ability to provide a wide scope of information on a domain | Fellers (1987) |

However, there are some setbacks also pertaining to the interviewing technique. Hart (1985) discovered that during the interview, the experts may become tired of having to repeat and continually elaborate on certain items. Subsequently, he may lose enthusiasm for the activity. Since people do not speak in complete sentences,

that is; they interrupt themselves, go at tangents, restart, tell anecdotes and other associated conversational behaviour; the practitioner must interpret and construct meaning from the acquired stream of information. As a result, it is possible to miss a significant fact. At the end of a detailed interviewing session, the practitioner is left with a huge amount of elicited information that must be translated into useable info. This task can be lengthy, tedious and complex. As a result of this, it is noted that the practitioner must have two key skills when dealing with interviews and knowledge acquired from the experts. Those skills are (1) the ability to interview the experts with specific, concise and really useful questions and (2) the ability to interpret huge amount of info acquired from the experts into useful ones that can be transformed into explicit knowledge. In addition, the practitioner should also have the required domain knowledge with varying depth, depending on circumstances in order to make the entire interview session and transformation of tacit to explicit knowledge to be successful.

Eliciting phase and requirement engineering is a multi-disciplinary human-centered process. The core activities involve eliciting, modeling and analyzing, communicating, agreeing and evolving requirements (Nuseibah & Easterbrook, 2000). Activities most often center on interactions with people. This requires an emphasis on skills that are not just technical in nature but that are sensitive to the perceptions, understanding and the overall dynamics of the human factor. As early as 1977, Taggart and Tharp (1977) identified behavioral characteristics of requirement engineering as a critical research area. Saiedian and Dale (2000) stress that requirement engineering techniques are not so much computer science

related, but they are more inclined towards organizational interaction, group interaction research, interviewing techniques and practical experiences. This is an important concept since unlike some other types of technical research that can be distilled and quantified in the absence of a human factor. The social context is much more important that in the design and coding phases of software development (Goguen & Linde, 1993). Reichental (2006) has defined human factor in elicitation stage as those dimensions that relate to the soft-skills of how individuals work together to derive requirements. Specifically, the dimensions identified are communications, involvement and resistance.

The process of requirement engineering is essentially a multifaceted communications and negotiations process involving a diverse group of participants (Aurum & Wohlim, 2003). In order to avoid project issues, participants should communicate with each other in as many as possible (Brooks, 1995). Holtzblatt and Beyer (1995) argue that requirements either succeed or fail based on the way in which people work together. Siddiqi (1994) suggests that requirement elicitation should not be based on capturing the needs of individual users; instead it should focus on the interaction of participants. According to Saiedian and Dale (1999), "direct customer involvement in requirement definition early-on is a consistent factor in successful programs". There is empirical research to support the hypothesis that there is a close correlation between user participant, user involvement and the user attitude in the software development process (Barki & Harwick, 1994). Participation is defined as the act of being a part of something, involvement is a subjective psychological state, and attitude is

an evaluation judgment of some person, object or event. The study demonstrated that as the dimensions of relevance and importance increased for an individual, there was a direct, positive impact on the participation, involvement and attitude of the user.

It is shown that there are distinctive challenges when conducting the elicitation process particularly in acquiring tacit knowledge. Therefore, some organizations have relied on two types of tacit transformation either (1) ad hoc, this is where employees informally share information and (2) job rotation, this is commonly implemented where employee transfers to other department permanently or temporarily to get experience in designated areas. Edgington and Chen (2002) discuss the fact that these transformation lack formality. They suggest that concepts contained within learning theory will contribute to the formalization of tacit knowledge transformation. Whereas rote learning relies on memorization; meaningful learning requires the learner understands the concepts and content. This usually infers that there is previous knowledge and experience. This is called discovery learning. It aligns well with tacit transformation as it shares close qualities. It is a combination of this insight and the weakness of current information systems theory to address non-explicit paradigms that causes Edgington and Chen to predict that information systems can only informally and indirectly contribute to the transformation process.

The manner in which tacit knowledge is disseminated in an organization is explored by Edging and Chen (2002). Their research is focused on how

information technology can contribute to the process of converting tacit knowledge to explicit knowledge, thus contributing to the organization's competitive advantage. In particular, they discuss how Nonaka's (1991) model for knowledge transformation: the knowledge spiral (Figure1) can represent the physical process. When tacit knowledge moves from one to another and remains tacit, it is called socialization. When it becomes explicit, it is called externalization. Explicit that joins with other explicit is called combination. Finally when explicit inspires new tacit, it is called internalization.

| | Tacit | Explicit |
|---|---|---|
| Tacit | Socialisation | Externalisation |
| Explicit | Internalisation | Combination |

Figure 1 : Nonaka's spiral knowledge

Juhana Salim, Mohd. Shahizan Othman & Sharhida Zawani (2005) propose that in order to effectively promote and implement a knowledge management process within an organization, three key elements must co-exist and work together; those are (1) people that adopt the tacit-explicit transformation process based on Nonaka's spiral model (1991), (2) processes in order to ensure the tacit-explicit transformation and (3) the technology as an enabler of the entire transformation. The objective of their approach is to develop a friendly knowledge culture and knowledge behavior among the organizational members where it will be supported by processes in order to improve knowledge sharing and enabled by

appropriate technology. Their proposal suggested that these three elements participation namely, people, process and technology must be integrated in order for a knowledge management process to succeed and that they must support each other throughout the entire process.

Some researchers have leveraged decision table in order to develop appropriate knowledge based system. Robben and Vanthienen (1993) emphasized that decision table and knowledge based system have striking similarities although both approaches concern with different aspects. Decision table traditionally stress the representation facilities (with additional checking for completeness, consistency and correctness) where else knowledge based systems are mainly dealing with knowledge formulation (modularity and flexibility) and inferences (performance and user friendliness). They described the decision table as a tabular representation that can be used to describe and analyse procedural decision situations, where the state of a number of conditions determines the execution of a set of actions. The representation is one in which all distinct situations are shown as columns in a table, such that every possible case is included in one and only one column in order to achieve completeness and exclusivity.

When dealing with knowledge based systems and decision table, a lot of efforts have been contributed to examine the area of validation and verification of the results, Cragun and Steudel (1987). Nevertheless, the author of this paper is

interested to apply the decision table as a fundamental approach for developing the conditional rules of the knowledge based prototype and less contribution is conducted on the validation and verification of the data. However, a great deal of effort is done to examine the effectiveness of tacit knowledge application in the problem domain.

## 3.0 Research Methodology

### 3.1. Methodology

The research methodology adopted in this proposal is based on the elicitation model developed by Fellers (1987) where the model separates the process into two key components: knowledge acquisition and system development. The discovery path is where the elicitator uses chosen technique to elicit the tacit knowledge from the experts. From holistic point of view, elicitation is one part of the cycle of organizational knowledge transfer (O'Dell & Grayson, 1988). Figure 2 illustrates that to effectively manage the knowledge, it must participate in a lifecycle. Elicitation tasks, represented by both identify and collect phases, are the critical antecedent to other phases in the cycle. None of these phases are mutually exclusive and therefore, failure in one has significant impact in the subsequent remaining lifecycle.

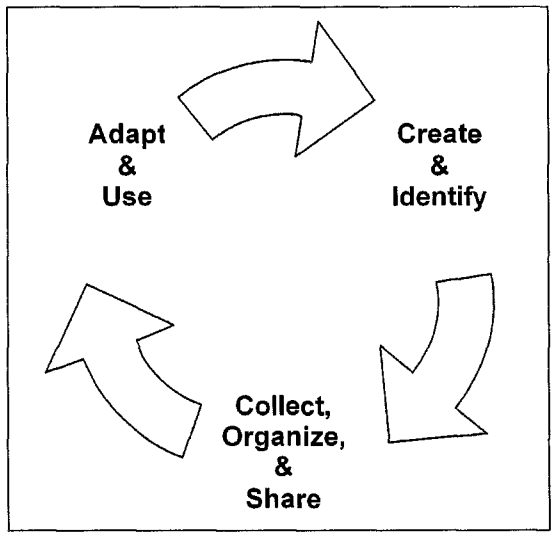


Figure 2 : Knowledge transfer process

According to Maiden and Rugg (1996), requirements are needed for three basic purposes : (1) to provide the specification to build solution, (2) to select a commercial-of-the-shelf (COTS) application and (3) to provide the content for a contract to purchase a solution. Conventional wisdom suggests that requirements constitute a complete statement about a system will do without indicating how it will do it.

In addition to Fellers (1987) model, the adopted elicitation phase proposed in this paper will also based on the partial and cumulative ideas presented by Siddiqi (1994), Brooks (1995) and Whitehead (2001) where users or the customers must be able to see what and how the system design during the requirement phase.

Brooks (1995) says that the requirements must contain everything that the users see, including the interfaces. He goes on saying that it must refrain from describing what the users do not see. He claims that this is the implementer's business and his design freedom must be unconstrained. This "what versus how" separation may not be so clear anymore. Siddiqi (1994) suggests that the requirements and design are highly interdependent. Requirements must consider the problem, the business domain, environmental constraints and methods available, thus challenging the single "what" focus to requirements. He also argues that the view of requirements depend on each problem level of abstraction. One person's "how" is another person's "what". He then goes on discussing that requirements cannot be represented by abstraction that is, they are free from assumptions. As an example, he argues that by default properties about the organizational structure become part of the requirement. Whitehead (2001) suggests that, "if it matters to the customer, it ought to be in the requirements document" (p. 185).

According to Reichental (2006), many organization use formal method (FM) in elicitation phase as part of the requirement engineering. Formal method is one in which the elicitator stresses on conducting the requirement in a formalilty like during the elicitation stage. According to Goguen (1996), the formalization in FM eliminates the vagueness and ambiguity of natural language while Brooks (1995) suggests that the

requirement must be precise, full and accurately detailed. However, there is a great deal of resistance to FM (Jones, Till & Wrightson, 1988). Formality incurs additional costs to organization. Nevertheless, the cost can be managed by refining ideas prior to formalization. The research by Jones et al. builds the case for FM. Formalisation results in providing elicitators with more precise properties on the domain being modeled. It provides structure to document, manage, and measure complex business processes. It enables the migration from vague, abstract requirement to formal, precise specification. It is therefore more useful at the early stage on the requirement engineering process.

As requirement for systems exist in a multitude of contexts and are influenced by human factors, formalization can be challenging. According to Goguen (1996), a sociological approach to understand the structure and methods may be more appropriate approach to requirement phase than sociological method. In short, some informality is necessary during the requirement stage in order to support effective elicitation process of acquiring tacit knowledge.

Since FM contributes to improved quality, fault reduction and other tangible benefits, implementing it can be considered a deliverable of process improvement. Engaging in process improvement requires an analysis of the current state. Houdek and Pohl (2000) present a research

on requirement engineering process of the Daimler Chrysler organization and at the end of their research, they concluded that in order to conduct effective requirement stage, defining clear requirement engineering process is an important first stage tasks. They discovered that the chosen organization did not have clearly defined objectives and steps with input and output deliverables. Due to this reason, the requirement engineering phase was done ineffectively. The significance of this finding suggests that (1) analysis of existing research engineering process is complex and requires a specific strategy in order to garner results and (2) defining clear research engineering processes is an important first stage in improving the research engineering. As part of the methodology, this research will also adopt the finding based on Houdek and Pohl research which is to define clearly the processes involved prior to the elicitation phase.

In order to acquire the required tacit knowledge, the research will also be adopting the four quadrant model suggested by Reichental (2006) where the model is based on the degree levels of structure and specificity. However, the researcher shall only make use of the combination techniques from the quadrant of more specific-less structured and less specific-more structured quadrant. Table 6 as shown below is how Reichental describes the four quadrant model.

Table 6 : Interview Dimensions mapped to Interview Types

| | Less Specific | More specific |
|---|---|---|
| Less Structured | • Interviewer lets interviewee do most of the talking<br>• Interview listens and encourages interviewee to think<br>• Often used as first pass interview to gather as much information as possible<br>• Digression is possible<br>• General domain information is sought<br>• Eg: Expert explains what he does in general terms | • Interview is conducted with specific agenda<br>• Agenda may be submitted to interviewee in advance<br>• Interviewer seeks specific info<br>• Interviewer works towards a desired goal for the meeting<br>• A small amount of tolerance for digression is permitted<br>• Eg: attempting to establish the correct process for a specific task. |
| More structured | • The interviewer has a specific goal in mind for the discussion. However, it is not limited to achieving this goal<br>• Interviewer does not influence direction of discussion<br>• Some digression is possible<br>• Eg: Understanding how an expert may approach a problem | • Interviewer uses specific questions to limit choice of answers to, for eg: yes or no<br>• Used when precise info is required<br>• Digression is prohibited<br>• Eg: Asking an expert to confirm whether a series of statement about a task are accurate |

The proposed prototype with a foundation knowledge-based system will focus mainly on assisting the task force group of Telekom Malaysia as well as assisting the provisioning employees at ground to perform their operational provisioning work. Besides automating the manual processes and propose suitable acceptable rules acquired from the Telekom Malaysia experts, the primary goal of the proposed prototype are to capture and store the tacit knowledge, codify them accordingly, construct the

acceptable system algorithm based on the specific rules analysed from the prior tacit knowledge and use them in the automation of the provisioning processes.

## 3.2. Physical System architecture

The following diagram (Figure 3) describes the infrastructure design that will support the implementation of the knowledge-based prototype

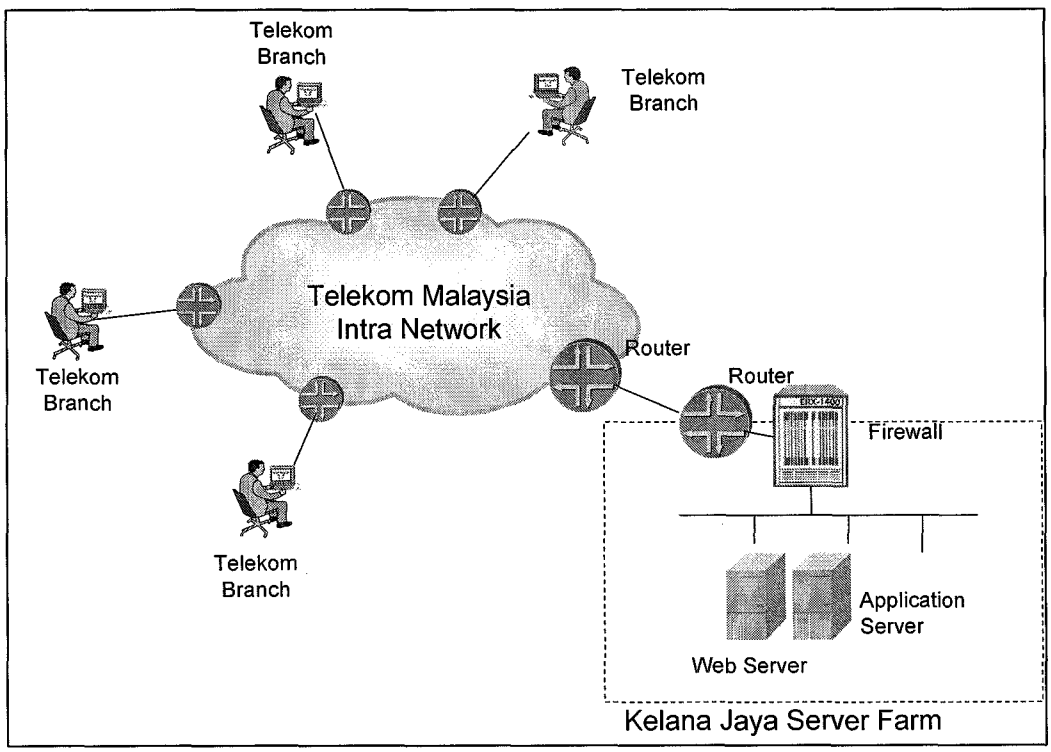


Figure 3 : Design of network infrastructure to support the knowledge-based prototype

## 3.3. Knowledge Codification

The next step once the tacit knowledge is acquired is to find a way to codify and organize knowledge into a form for others to use when needed. Knowledge codification is organizing and representing knowledge before

it is accessed by authorized personnel. For the scope of this proposal, I will use the decision table and decision tree in order to organize the knowledge so that it can be accessible, explicit and easy to access. Codification process can also be perceived as the process of transforming the tacit knowledge to explicit knowledge in a usable form for organizational members.

A decision table is more like a list of conditions with their respective values matched against a list of conditions. Where else, decision tree is a hierarchically arranged semantic network that is closely related to a decision table; composed of nodes representing goals and links that represents decisions and outcomes. Other researcher Verhelst (1980) defines decision table as a table representing the exhaustive set of mutual exclusive conditional expressions, within a predefined problem area. In his study, Verhelst represented all conditional states pertaining to the condition domain into an exclusive action within a cell. By applying this approach he can emphasise the completeness and the exclusivity of all problem conditions and corresponding actions.

The results obtained from the decision table and decision tree will be used as the reference to build up the rules for the prototype. In other words, the prototype uses the rule-based condition as a framework of its system development and implementation.

# 4.0 System Implementation and Results

## 4.1. System Implementation

Prior to the system development and implementation, a structured approach has been conducted to understand the current problem domain and identify which tacit knowledge is relevant to the improvement of the business process particularly in the aspect of delivering the Telekom Malaysia services to GITN. Identification of the tacit knowledge becomes the basis for the conversion to explicit knowledge and how this knowledge can be interpreted into the program sequences. Among the processes that have been developed to assist in the system foundation is the development of knowledge maps pertaining to the service order provisioning and the decision tree.

### 4.1.1 Decision Table

The decision table associated with the process of identification of the relevant tacit knowledge is shown below in Figure 4.0. The representation of problem conditions and corresponding actions is similar to the one recommended by Robben and Vanthienen (1993).

| Service has complete end-to-end infra? | Yes | | | | | | | | | | | | | | | | No | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Local Access Ready? | - | | | | | | | | | | | | | | | | Yes | | | | No | | | |
| MLCN inventory ready? | | | | | | | | | | | | | | | | | Yes | | No | | Yes | | No | |
| COINS inventory ready? | | | | | | | | | | | | | | | | | - | No | Yes | No | Yes | No | Yes | No |
| Any problems during MLCN provisioning? | Yes | | | | | | | | No | | | | | | | | - | - | - | - | - | - | - | - |
| Any problems during COINS provisioning? | Yes | | | | No | | | | Yes | | | | No | | | | - | - | - | - | - | - | - | - |
| Any problems during modem installation or service testing? | Yes | | No | | Yes | | No | | - | | - | | Yes | | No | | - | - | - | - | - | - | - | - |
| Any problems during assignment of local access (copper/fibre)? | Yes | - | Yes | No | Yes | No | Yes | No | - | - | - | - | - | - | Yes | No | - | - | - | - | - | - | - | - |
| Assigned to CAN | - | - | - | - | - | - | - | - | - | - | - | - | - | - | X | | - | - | - | - | x | x | x | x |
| Assigned to MLCN | x | x | x | x | x | x | x | x | - | - | - | - | - | - | - | - | - | - | x | x | - | - | - | - |
| Assigned to COINS | - | - | - | - | - | - | - | - | x | x | x | x | - | - | - | - | x | x | - | - | - | - | - | - |
| Assigned to CNO | - | - | - | - | - | - | - | - | - | - | - | - | x | x | - | - | - | - | - | - | - | - | - | - |
| Service can be completed & handover to GITN | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | x | - | - | - | - | - | - | - | - |

Figure 4.0 : Decision Table in relation to service order provisioning

The tabular expression of the decision situation is represented by the separation between conditions and actions on one hand and between subjects and conditional expressions on the other hand. The decision table is represented as a table which is split by a double line both vertically and horizontally resulting in four quadrants. The upper left quadrant as highlighted in light yellow color as depicted in Figure 4 represents the conditions of situation, the right upper quadrant in light pink represents the states, the lower left quadrant in light green represents the subject or decision and the lower right quadrant represents the conditional expressions of the subject.

### 4.1.2 Decision Tree

The decision tree is based on the knowledge map developed earlier and is presented in the Figure 5.0 in Appendix A

### 4.1.3 Summary of Tacit Knowledge Codification

The interviews have been conducted to several Telekom Malaysia experts across different divisions that are directly involved in the service provisioning of the GITN orders. The main objective of the interviews is to acquire how the experts handle the service delivery problems and what solutions or procedures they adopt in relation to the problems. Based on the outcomes of the interviews, below is the summary of the solutions based on the tacit

knowledge codified and gathered from different divisions as illustrated in Table 7. The key question asked to all experts is what are the main reasons constituting to the delay of the service delivery once the expert receives the service orders. The tacit knowledge codification format is later used in building up the rules for the prototype. Based on the feedback given, the outcomes were summarized into appropriate reason of codes.

| No | Experts from which division? | Responses from the experts due to service delivery delay | Relevant reason of codes | Assigned to which divisions (or Baskets) |
|---|---|---|---|---|
| 1. | CNO | Service cannot be installed due to premise is not ready. GITN needs to ensure the readiness of the premise | Premise Not Ready | GITN (KIV) |
| 2. | CNO | Service cannot be installed due to CPE is not ready. GITN needs to ensure the readiness of the premise | CPE Not Ready | GITN (KIV) |
| 3. | CNO | Service cannot be installed due to Internal Wiring is not ready. GITN needs to ensure the readiness of the premise | Internal Wiring Not Ready | GITN - INTERNAL WIRING |
| 4. | CNO | Service cannot be installed due to branch office refuses entry. GITN needs to ensure the readiness of the premise | Branch Office Refuse Entry | CGG-SALES |
| 5. | CNO | Service cannot be installed due to premise is not ready. GITN needs to ensure the readiness of the premise | Contact Person Not Aware/Not In During Appointment | CGG-SALES |
| 6. | CNO | Service cannot be installed due to premise is not ready. GITN needs to ensure the readiness of the premise | Customer Request Cancellation | GITN (KIV) |
| 7. | CNO | Service cannot be installed due to faulty pair. Our staff needs to conduct further testing and may need to repair | Faulty Pair | CNO-PERINGKAT AWAL |
| 8. | CNO | Service is not ready due to faulty of MLCN channel. MLCN team needs to conduct proper testing | MLCN Channel Faulty | MLCN TESTING |
| 9. | CNO | PTL1 needs to reprocess the order due to high DB loss. | High DB Loss | PTL1 - PRE-CANCEL |

| | | | | |
|---|---|---|---|---|
| 10. | CNO | Needs a high speed modem. HDSL required. | HDSL Required | CAN - RETURN ORDER |
| 11. | CNO | Further test needs to be conducted due to high bit error. | High Bit Error | CNO to RE-TEST |
| 12. | CNO | Requires NT due to shortage of NT. MLCN team must re-test the circuits upon installation of NT | Shortage of NT | MLCN TESTING |
| 13. | CNO | Service cannot be installed. Still waiting for the order to be distributed | Order Not Received | PTL2-KICKOFF |
| 14. | CNO | Cannot terminate the service due to no DP availability. CAN group needs to deploy new infrastructure - DP | No DP | CAN - RETURN ORDER |
| 15. | CNO | Service cannot be delivered due to network under construction. CAN group needs to deploy new infrastructure | Network Under Construction | CAN - RETURN ORDER |
| 16. | CNO | HDSL Requisition stage. CAN group needs to deploy new infrastructure HDSL | HDSL Requisition | CAN - RETURN ORDER |
| 17. | CNO | Line Extender Under Requisition stage. CAN group needs to deploy new infrastructure | Line Extender Under Requisition | CAN - RETURN ORDER |
| 18. | CNO | Cannot deliver the service due to MDF-PCM Tie Cable shortage | MDF-PCM Tie Cable Required | CAN - RETURN ORDER |
| 19. | CNO | Cannot deliver the service due to Fibre Card shortage | Fibre Card Not Available | CAN - RETURN ORDER |
| 20. | CNO | Cannot deliver the service due to MLCN Node Not Available | MLCN Node Not Available | LSS |
| 21. | CNO | Cannot deliver the service due to Channel Full | Channel Full | LSS |
| 22. | CNO | Cannot deliver the service due to MLCN Capacity Under Construction | MLCN Capacity Under Construction | LSS |
| 23. | CNO | Cannot deliver the service due to Change to/from DDN (Tellabs/M2/M1). PTL1 must change the inventory for this order | Change to/from DDN (Tellabs/M2/M1) | PTL1 - PRE-CANCEL |
| 24. | CNO | Cannot deliver the service due to No PCM Channel. CAN group to provide the infra | No PCM Channel | CAN - RETURN ORDER |
| 25. | CNO | Cannot deliver the service due to MDF-PCM Tie Cable Full . CAN group to provide the infra | MDF-PCM Tie Cable Full | CAN - RETURN ORDER |
| 26. | CNO | Cannot deliver the service | Delay in | CAN - RETURN |

| | | | | |
|---|---|---|---|---|
| | | due to Delay in Channel/Circuit Assignment. CAN group to provide the infra | Channel/Circuit Assignment | ORDER |
| 27. | CNO | Cannot deliver the service due to Faulty Link. CAN group to provide the infra and repair the equipment | Faulty Link/Need Repair | CAN - RETURN ORDER |
| 28. | CNO | No Coaxial Tie Cable/Connector for PCM-MDF | No Coaxial Tie Cable/Connector for PCM-MDF | CAN - RETURN ORDER |
| 29. | CNO | Discovered that order is still at Peringkat Awal although the service has been port completed. COINS to post complete | PostCompleted (20) but still Peringkat Awal(15) | COINS FINAL POSTCOMPLETION |
| 30. | CNO | Needs to change the internal wiring type (Copper to Coax) | Change Internal Wiring (Copper to Coax) | GITN - INTERNAL WIRING |
| 31. | CNO | Needs to change the internal wiring type (Coax to Copper) | Change Internal Wiring (Coax to Copper) | GITN - INTERNAL WIRING |
| 32. | CNO | Cannot contact the person in Charge. GITN to ensure the person availability | Contact Person Not Valid | GITN (KIV) |
| 33. | CNO | Service cannot be given due to fibre card faulty. Requires re-testing of circuit | Fibre Card Faulty | CNO-PERINGKAT AWAL |
| 34. | CNO | Wrong Site Address. PTL1 to cancel the order | Wrong Site Address | PTL1 - PRE-CANCEL |
| 35. | CNO | Service cannot be given due Kajisiasat - Siasat Siap process. | Kajisiasat - Siasat Siap | PTL2-KICKOFF |
| 36. | CNO | Change DP Copper to/from Fiber Port | Change DP Copper to/from Fiber Port | PTL1 - PRE-CANCEL |
| 37. | CNO | PreTest Done. Needs to reprocess the order | PreTest Done | REPROCESS [PTL1] |
| 38. | MLCN | No Node. LSS to provide the infra | No Node | LSS |
| 39. | MLCN | Node Full. LSS to provide the infra | Node Full | LSS |
| 40. | MLCN | D/A Full LSS to provide the infra | D/A Full | LSS |
| 41. | MLCN | to Add Card LSS to provide the infra | to Add Card | LSS |
| 42. | MLCN | Wait C/A LSS to provide the infra and conduct the investigation | Wait C/A | LSS - MLCN Kajisiasat |
| 43. | MLCN | Marconi 1: to Check Bandwidth. LSS to provide the infra and conduct the investigation | Marconi 1: to Check Bandwidth | LSS - MLCN Kajisiasat |
| 44. | MLCN | No Infra Info (Fibre/Copper?). LSS to provide the infra and conduct the investigation | No Infra Info (Fibre/Copper?) | LSS - MLCN Kajisiasat |

| | | | | |
|---|---|---|---|---|
| 45. | MLCN | No E1C. LSS to provide the infra of E1C | No E1C | E1C (LSS) |
| 46. | MLCN | No Work Order Number. PTL2 to re-distribute the order | No Work Order Number | PTL2-KICKOFF |
| 47. | MLCN | Needs to change the internal wiring type (Copper to Coax) | Change Internal Wiring (Copper to Coax). | GITN - INTERNAL WIRING |
| 48. | MLCN | Needs to change the internal wiring type (Coax to Copper) | Change Internal Wiring (Coax to Copper). | GITN - INTERNAL WIRING |
| 49. | MLCN | No Internal Wiring. GITN to provide the required internal wiring | No Internal Wiring | GITN - INTERNAL WIRING |
| 50. | MLCN | No 2Mbps link/drop-propose Wireless | No 2Mbps link/drop-propose Wireless | CAN - Wireless (Other Technology) |
| 51. | MLCN | Migration/Upgrade cct-PTL2 to set time for upgrading | Migration/Upgrade cct-PTL2 to set time for upgrading | PTL2-KICKOFF |
| 52. | MLCN | No Bandwidth (leg A to leg B). LSS group to provide the infra | No Bandwidth (leg A to leg B). | LSS |
| 53. | CAN | Sales to Fill in Form to Create Project for new infra development | Fill in Form to Create Project | CGG-SALES |
| 54. | CAN | Sales To Confirm Installation Site Address | To Confirm Installation Site Address | CGG-SALES |
| 55. | CAN | Customers disallow to Enter/require Letter. | Customers disallow to Enter/require Letter. | CGG-SALES |
| 56. | CAN | Local Access Infra Completed. Order processor can continue with order distribution | Local Access Infra Completed | REPROCESS [PTL1] |
| 57. | CAN | DP Tambahan OK requested by CNO has been commissioned. To proceed with installation. | DP Tambahan OK (Requested by CNO) | CNO-PERINGKAT AWAL |
| 58. | CAN | Deployment of HDSL is complete (Requested by CNO). To proceed with installation | HDSL OK (Requested by CNO) | CNO-PERINGKAT AWAL |
| 59. | CAN | Customers disallow to Enter/require Letter | Customers disallow to Enter/require Letter | GITN (KIV) |
| 60. | CAN | E1 Modem has been deployed and ready for service.OK. To proceed with installation | E1 Modem OK.. | CNO-PERINGKAT AWAL |
| 61. | CGG | Premise Not Ready. Sales/GITN to clarify with customer | Premise Not Ready.. | GITN (KIV) |
| 62. | CGG | Customer Request Cancellation. Sales/GITN to clarify with customer | Customer Request Cancellation.. | GITN (KIV) |
| 63. | CGG | HDSL Required. CAN to provide the infra. | HDSL Required.. | CAN |
| 64. | CGG | No Infrastructure-fibermux,minimux,etc. CAN | No Infrastructure-fibermux,minimux,etc. | CAN |

| | | | | |
|---|---|---|---|---|
| | | to provide the infra. | | |
| 65. | CGG | MDF-PCM Tie Cable Required. CAN to provide the infra. | MDF-PCM Tie Cable Required.. | CAN |
| 66. | CGG | Service cannot be given due to Fibre Card Not Available. CAN to provide the infra. | Fibre Card Not Available.. | CAN |
| 67. | CGG | Service cannot be given due to No PCM Channel. CAN to provide the infra. | No PCM Channel.. | CAN |
| 68. | CGG | No Coaxial Tie Cable/Connector for PCM-MDF. CAN to provide the infra. | No Coaxial Tie Cable/Connector for PCM-MDF.. | CAN |
| 69. | CGG | Service cannot be given due to Contact Person Not Valid.. | Contact Person Not Valid.. | GITN (KIV) |
| 70. | CGG | Need to Propose Wireless-VSAT,etc. | Propose Wireless-VSAT,etc. | CAN - Wireless (Other Technology) |
| 71. | CGG | Installation Address successfully verified. PTL1 to proceed with reprocess of order | Installation Address successfully verified | REPROCESS [PTL1] |
| 72. | GITN | Internal Wiring Done - new I/W. PTL2 to proceed with order distribution | Internal Wiring Done - new I/W | PTL2-KICKOFF |
| 73. | GITN | Internal Wiring Done - Change Copper to Coaxial. Order processor to proceed with order distribution. | Internal Wiring Done - Change Copper to Coaxial | PTL2-KICKOFF |
| 74. | GITN | Internal Wiring Done - from Coaxial to Copper. Order processor to proceed with order distribution. | Internal Wiring Done - from Coaxial to Copper | PTL2-KICKOFF |
| 75. | GITN | GITN agrees to Cancel Order. PTL1 to reprocess the order | GITN agrees to Cancel Order | REPROCESS [PTL1] |
| 76. | GITN | PTL1 has successfully verified the order. To proceed with the order distribution | Order has been correctly verified, pls continue!! | REPROCESS [PTL1] |
| 77. | CAN | CGG needs to Fill in Form to Create Project – NPP02 | Fill in Form to Create Project.. | CGG-SALES |
| 78. | CAN | CGG to Confirm Installation Site Address.. | To Confirm Installation Site Address.. | CGG-SALES |
| 79. | CAN | Customers disallow to Enter/require Letter. CGG to provide the letter of authorisation | Customers disallow to Enter/require Letter.... | CGG-SALES |
| 80. | CAN | Local Access Infra Completed. PTL1 to proceed with the order | Local Access Infra Completed.. | REPROCESS [PTL1] |
| 81. | CAN | CNO to confirm the additional DP is working fine. Once verified, CNO to | DP Tambahan OK (Requested by CNO).. | CNO-PERINGKAT AWAL |

| | | | | |
|---|---|---|---|---|
| | | proceed with the installation | | |
| 82. | CAN | CNO to confirm the additional HDSL is working fine. Once verified, CNO to proceed with the installation | HDSL OK (Requested by CNO).. | CNO-PERINGKAT AWAL |
| 83. | CAN | .Customers disallow to Enter/require Letter. GITN to provide the letter | .Customers disallow to Enter/require Letter.. | GITN (KIV) |
| 84. | CAN | E1 Modem works fine. CNO to proceed with the installation | E1 Modem OK... | CNO-PERINGKAT AWAL |
| 85. | CAN | CNO to verify Fiber/Copper Infrastructure at site. Once verified, CNO to proceed with the installation | CNO to verify Fiber/Copper Infrastructure at site. | CNO-Pre Test |

Table 7 : Tacit Knowledge Codification

### 4.1.4 System development and Adopted Business Process

The prototype is a web-based system and it is developed with a key objective in mind to provide widest accessibility via web browsers to the users without the need install any client programs at user end. The prototype facilitates the updates of data with respect to the service order provisioning based on the manual inputs entered by the users inclusive of the project manager team as well as the operational provisioning team nationwide. The users must update the progress status of each service order captured in the prototype every time there is a change occurred to the service order. When updating the data, the users must change the status of order according to the pre-determined reason of codes. Each reason of code has been assigned to respective division or also known as baskets. The values of basket are the key differentiators for the

prototype to produce the desired reports for tracking and monitoring purposes.

The system development of the desired prototype requires a structured phases of implementation. Kindly refer to Figure 6 in Appendix B for the project development and implementation timeline of the prototype.

Examples of reports produced by the prototype are presented in Figure 7 and Figure 8 in Appendix C.

The web-programming used in developing the prototype is PHP version 5.0, web server is Internet Information Server (IIS) and a simple database from Microsoft Access 2000.

The prototype is a single system with no integration with the current OMS. As such it requires the manual updates by the respective users to ensure the latest status of the service order provisioning. It is highly dependant on the commitment of all users to consistently follow the business process where each time there is a change in the status of the service order, the user must entered into the prototype. Based on this approach, the accuracy and integrity of data is 100% dependant on the manually data entry.

Figure 9 in Appendix D provides page-by-page view of the prototype.

Figure 10 in Appendix E provides the system coding of the prototype.

## 4.2. Results

Developing the knowledge based prototype showed that the decision table technique was not only useful for verification of the consistency of tacit knowledge in the service delivery and provisioning domain, but also for supporting the formalization of knowledge process. The application of tacit knowledge in the form of system automation as presented by the prototype has successfully able to assist the non-expert TM employees to assign correct actions to the provisioning problem they are currently facing.

Some of the key improvements with respect to the prototype implementation are listed below:

i) Reduce the unnecessary time spent by the project manager team to investigate the service provisioning problem at each order and identify the actual delay reason. This is due to the fact that the prototype enables automatic assignment of service order to respective provisioning group based on the reasons of outstanding chosen by the users. The reasons of outstanding

are the key attributes in the prototype that are originally converted from the tacit knowledge.

ii) Cut down the unnecessary time spent to produce the service provisioning status reports for the management. Previously, the project team requires one week time to produce the service delivery report and only able to present the report to the management with data of one week delay. However, based on the prototype, the service delivery reports can be produced at any time.

iii) Real-time reports based on analysed data from the prototype is a key driver for the management decision making especially the ones that involves financial impact to the organization. There is no out-of-date report and management is able to respond to service provisioning problem immediately.

iv) Fast and accurate provisioning status reports enables the project manager team to identify the real problem which constitutes to the delay of the service delivery.

v) Eliminate the need to manually maintain the records of inventory assignment, status reports and provisioning history as all data are stored and updated in a single database by the prototype.

# 5.0 Discussions and Recommendations

## 5.1. Discussions

The outcome of this research suggests that the approach of converting the tacit knowledge into explicit knowledge and translate them into a system rules in a prototype in order to assist the project manager team in their operational business process is reasonably effective. On top of leveraging the expertise in the form of system automation, it is apparent that the prototype has become a key tool for the project manager team to automate their current manual processes such as infra checking of the services prior to the order capture. The project manager team can make use of the prototype to keep track and record systematically the inventory assigned to the requested services without a need to manually maintain the excel spread sheet.

The effectiveness of the prototype highly depends on the commitment of the related organization namely Telekom Malaysia to adopt the values of tacit knowledge management in their operational business process. As this study generally focuses only on investigating the effectiveness of tacit knowledge adoption in the area of service provisioning and considerably regarded as new area to Telekom Malaysia, it may affect the effectiveness of the research outcome. A longer time may be needed in order to instill this value into the organizational business process and produce the desired result from the prototype.

## 5.2. Recommendations

As the key objective of developing the prototype is study on the effectiveness of applying the tacit knowledge in a form of knowledge-based system in the area of service provisioning, the author has developed the prototype with minimal server capacity which is using the web-programming language PHP and a simple database called Microsoft Access. Due to its simplicity, the server capacity is not able to handle many concurrent users at one time and therefore can only support four simultaneous users. Besides that, due to the centralized database approach, the server running Microsoft Access database is not able to handle all requests from the operational team that are scattered nationwide. There are many times that the server responds with busy remark and users need to wait a while before useful info is returned by the server.

The integrity and accuracy of the prototype record is based on the manual updating process by the users which include the project manager team as well as the operational provisioning team nationwide. There is no system integration between the prototype and the existing OMS. Due to this approach, the project manager team must ensure that the data is consistent especially with that of the existing OMS data at all time. There are some records that need to be manually entered into the prototype based on the records in the OMS. In the event that the record has changed in OMS, the

project manager team must promptly update the data in the prototype accordingly.

In order to improve the system implementation especially the server response and management of tacit knowledge against the cultural challenges, there are several areas that can be further investigated and studied. The followings are the key areas that can be studied for improvement:

i) Replacement of the simple database running over Microsoft Access platform into a proper and more powerful database server such as Oracle DB or Microsoft SQL Server database.

ii) System integration between the prototype and the existing OMS can be implemented to eliminate the manual entry of data into the prototype and ensure 100% data integrity and accuracy.

iii) Centralized database can be improvised into distributed database based on the regions and the volume of traffic request to the server.

iv) Related organization can play more effective role in order to instill the management of tacit knowledge into the day-to-day business process. In order to promote the process improvement for managing the tacit knowledge, the leader in the respective

organization must create the culture for exploiting organizational knowledge. They must lead the effort that encourages quality discourse and relationships at all levels. Any dysfunction in this area will greatly reduce the free flow of explicit and tacit knowledge. Some researchers have conducted researches on similar topic, for example; Johannessen et al. (2001) emphasizes that organization must stress the importance of total knowledge particularly in the area of tacit knowledge management. Their work is complemented by a similar discussion from Kakabadse and Kouzmin (2001). Their argument is that the organization has emphasized the building of knowledge management system to store, separate and transfer knowledge. Further in-depth study can be conducted in the area of organizational commitment to tacit knowledge management and propose the best approach on how organization can effectively implement this knowledge management in their day-to-day business areas.

v) Further research on real-time data mining technique can be conducted on the corresponding OMS in relation to assist the management on decision making areas. This study approach has produced a method where data mining can be conducted in real-time with respect to the data stored in OMS without a need to refer to data warehouse. The current practice of producing

reports is to data mine the data from the data warehouse where data is normally out of date and less useful for the management decision making. The proposed study in this area can provide ample recommendation on level of real time of data mining and best approach without affecting the performance of the OMS itself.

## 6.0 Conclusions

Some of the key issues pertaining to management of tacit knowledge in the specific business domain are how the challenges of tacit knowledge arise can be handled. Among effective approach to overcome the challenges is how the related organization can play their role to make use the tacit knowledge from their experts. Tacit knowledge is increasingly important as organization adopts the process improvement trend. In order to have process improvement, there is a need for increased knowledge creation, dissemination and use. The lack of preserving the tacit knowledge and maximizing it has not become an organizational culture in many local and domestic companies. The similar scenario also happens in Telekom Malaysia.

This is one of the key reasons why the author has taken the initiative in transforming the underlying tacit knowledge among the Telekom Malaysia experts into a system which will be used by many non-expert employees. The use of the system as part of the organizational business process will indirectly share and transfer the tacit knowledge with other employees particularly in the specific area of monitoring and tracking of service order provisioning. It is the goal of the research that via the proposed prototype that adopts the foundation from the research findings, the system will be able to resolve main problems pertaining to the GITN order provisioning and service delivery. Therefore, it no recommended that in order to improve the efficiency of its business process particularly in

fulfillment and provisioning area, Telekom Malaysia should leverage this provisioning system.

Some key advantages that are expected to arise as a result from developing and implementing the proposed knowledge-based prototype in the specific TM business domain are as follows:

- Better decision making and management control. Accurate, on-time, available and accessible information to appropriate individuals.
- Organization knowledge is captured effectively and successfully.
- Knowledge Culture was instilled in the organization.
- Resource utilization is improved, and the ability to grow without proportional cost is increased.
- Expedite many management works which in return give more time to do planning.
- Organization has the ability to react faster to changes in economy and government policies particularly in the Malaysian Communications & Multimedia Commissions (MCMC) regulation and policies on the telecommunication service providers
- Business processes to be improved significantly; simplified and reduced non-value added activities; enterprise view incorporating cross functional focus and information availability

Apart from offering the normal automation capabilities by the normal information system, this system also serves as a platform for handling the knowledge-based resources pertaining to the delivery of the GITN service orders. The recommendations presented in this proposal are specifically written to tackle key problems currently faced by the Telekom Malaysia project team as well as the provisioning employees at the ground level.

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# APPENDIX A

# Appendix A

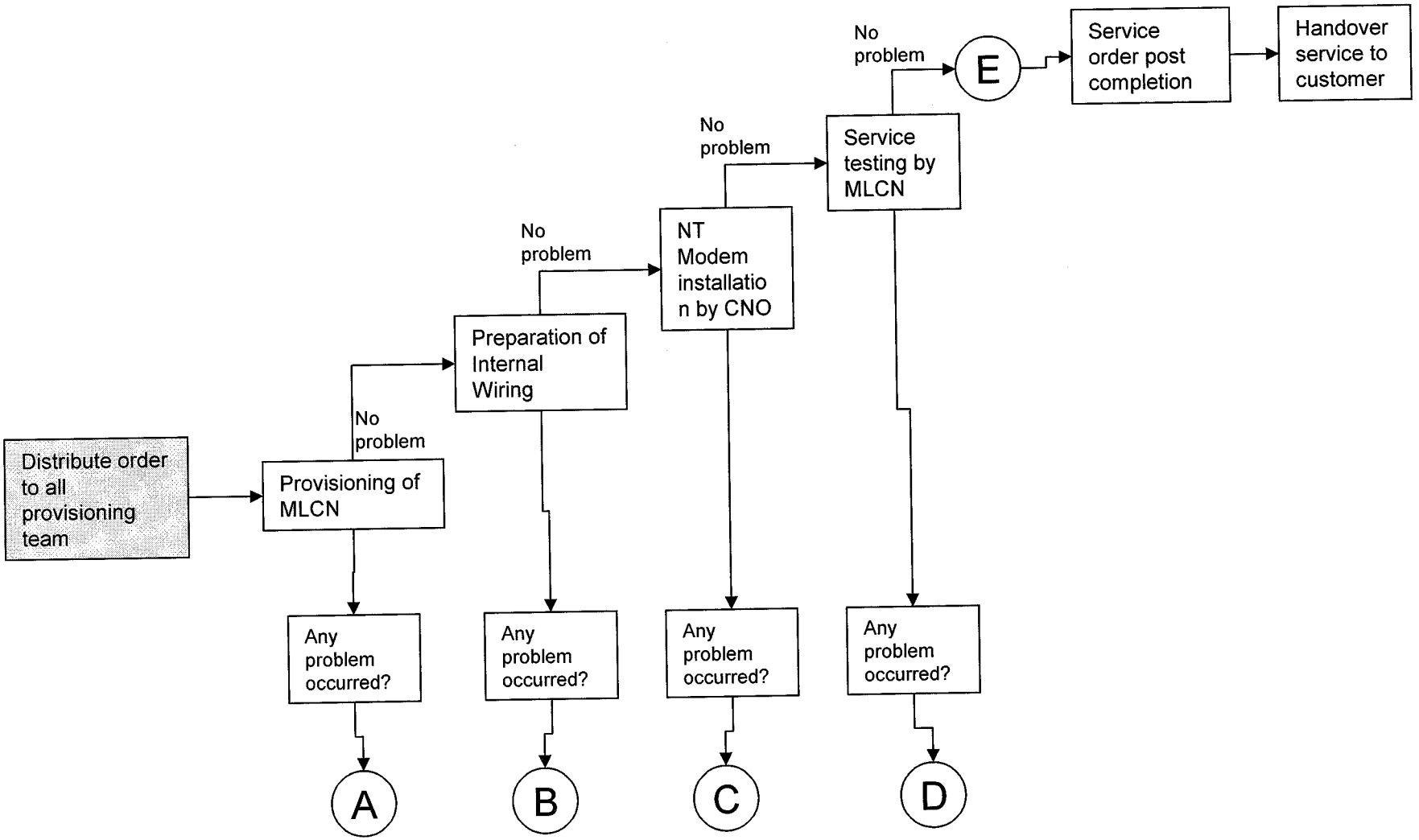



Figure 5(a) : Decision Tree in relation to service order provisioning

# Appendix A

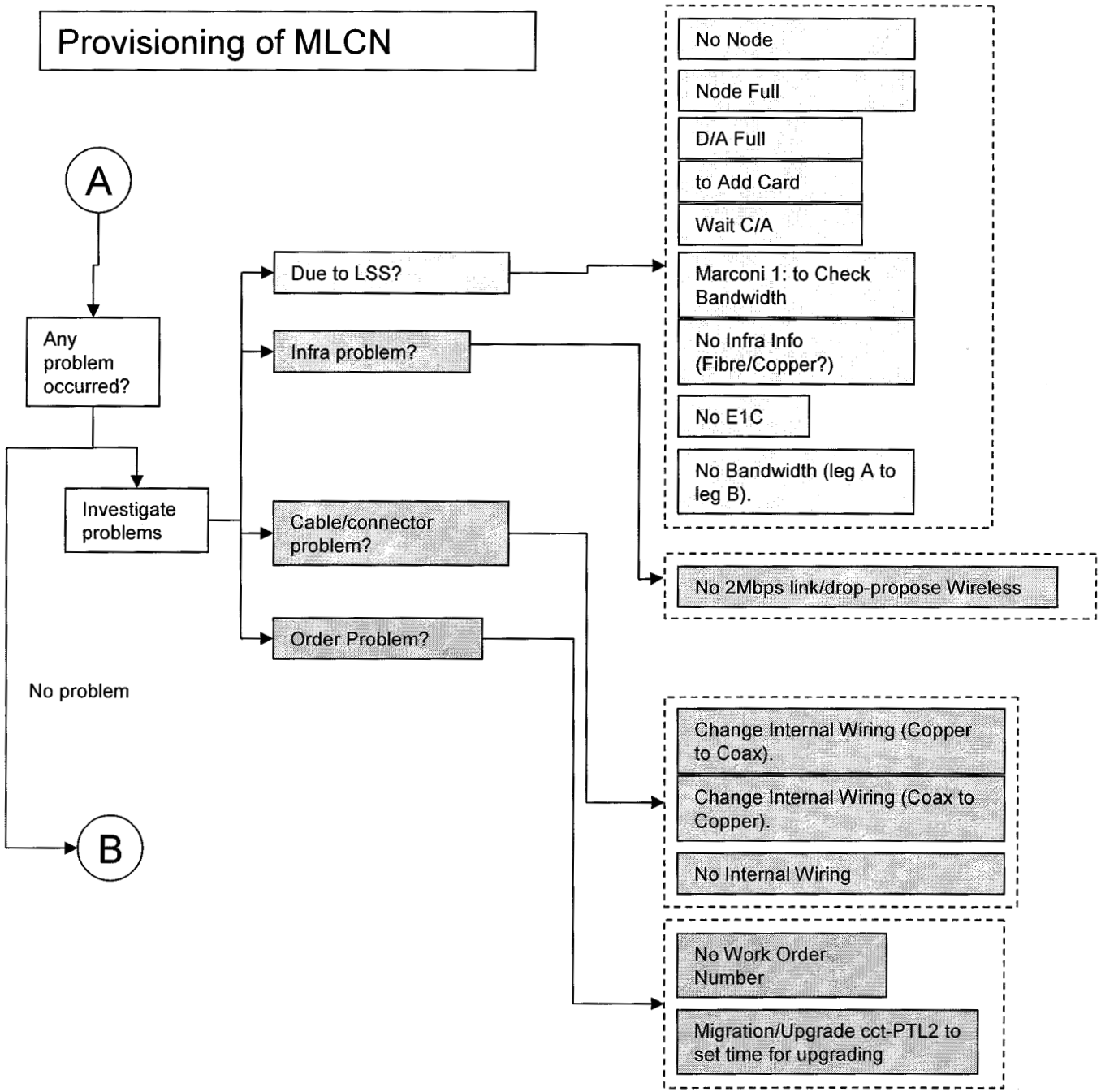



Figure 5(b) : Decision Tree in relation to service order provisioning

# Appendix A

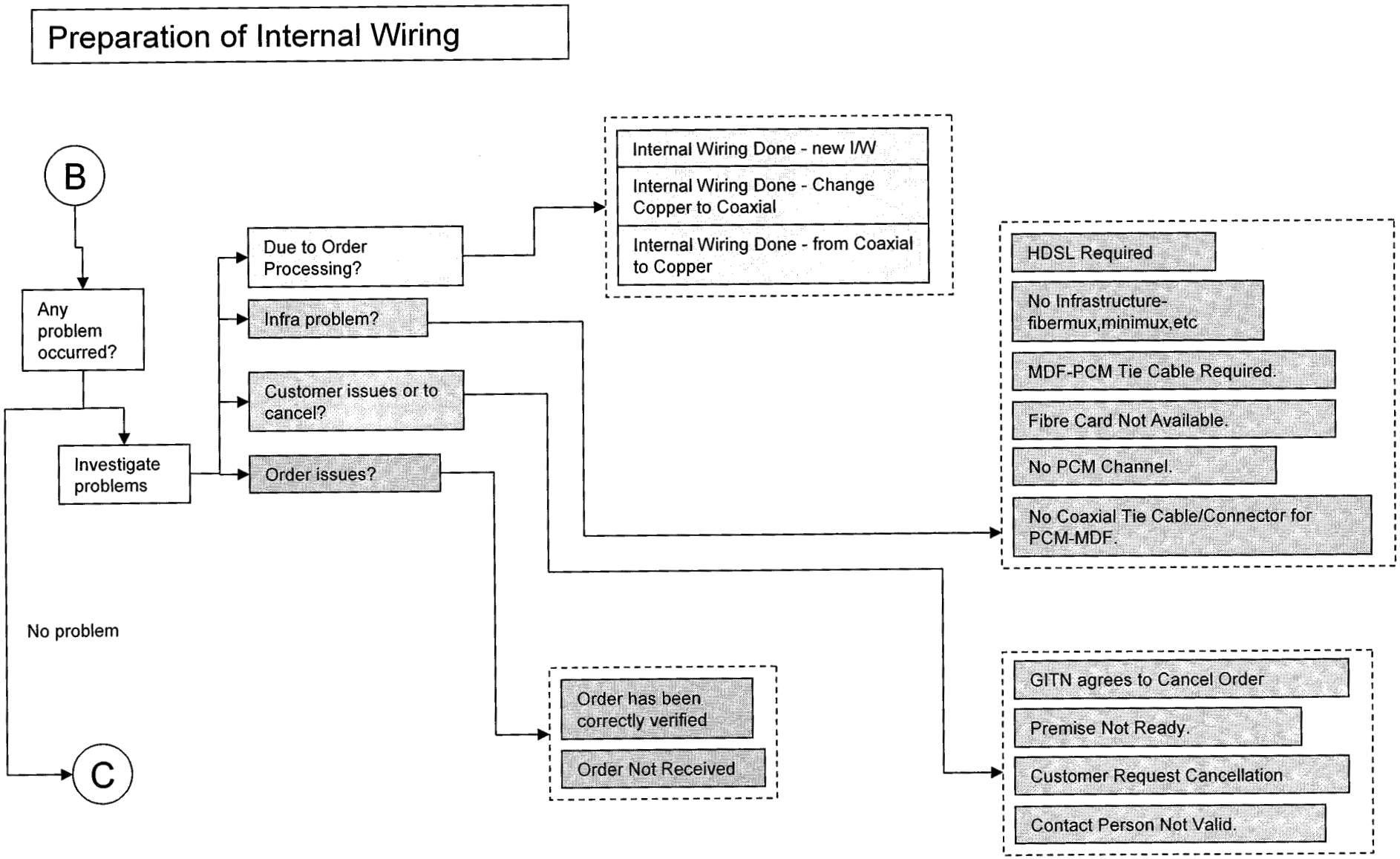



Figure 5(c) : Decision Tree in relation to service order provisioning

Appendix A

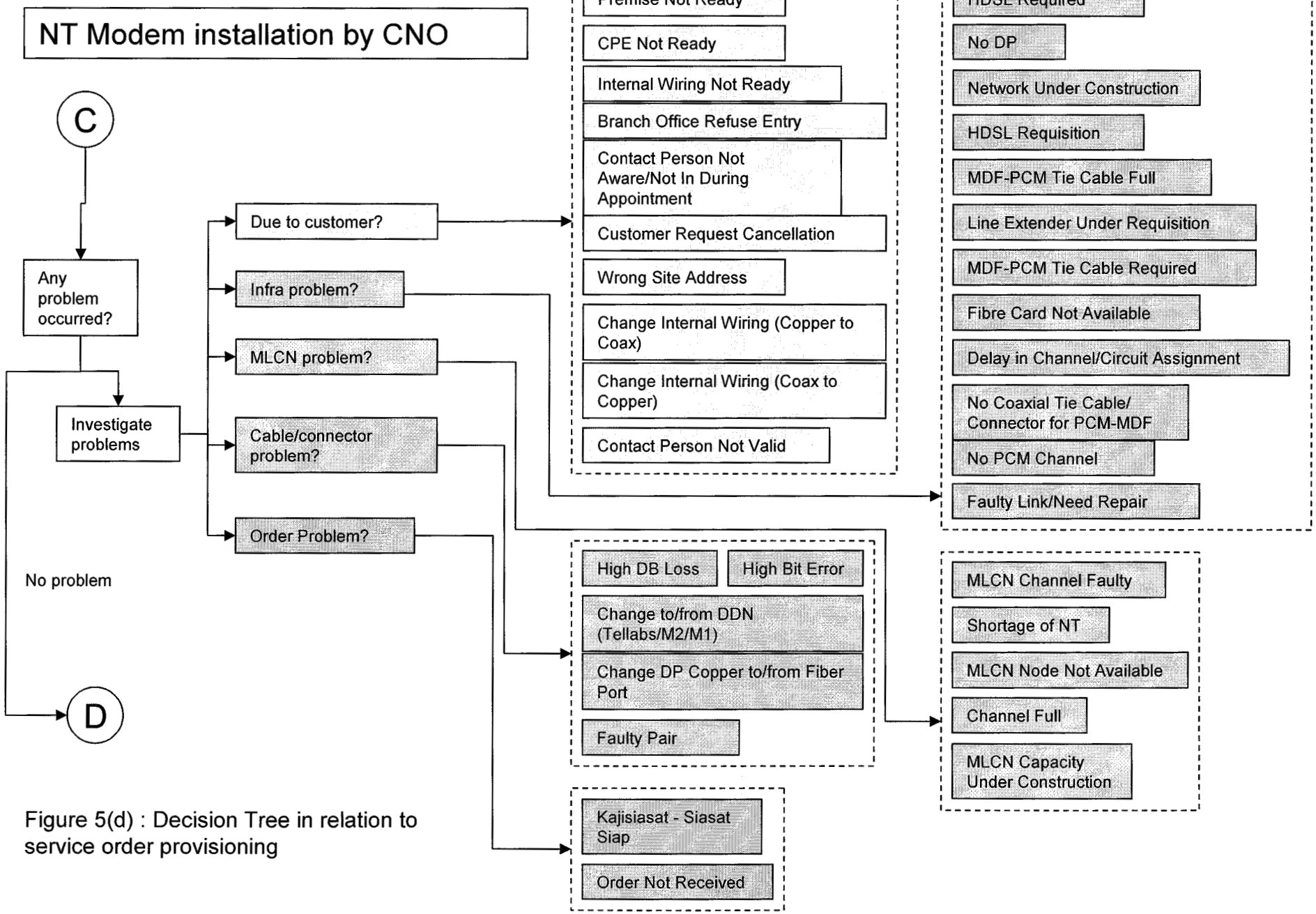



Figure 5(d) : Decision Tree in relation to service order provisioning

# Appendix A

Service testing by MLCN

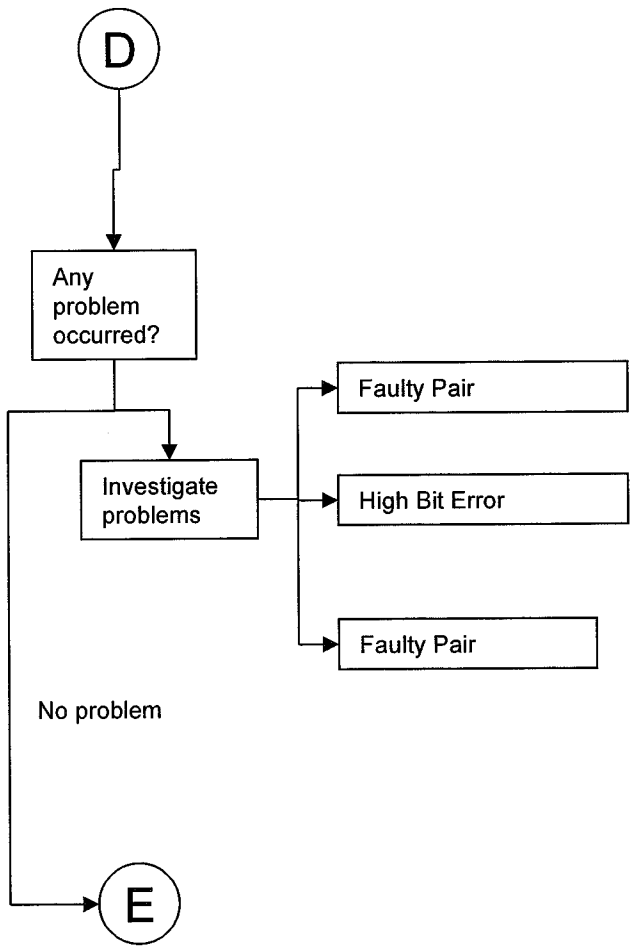


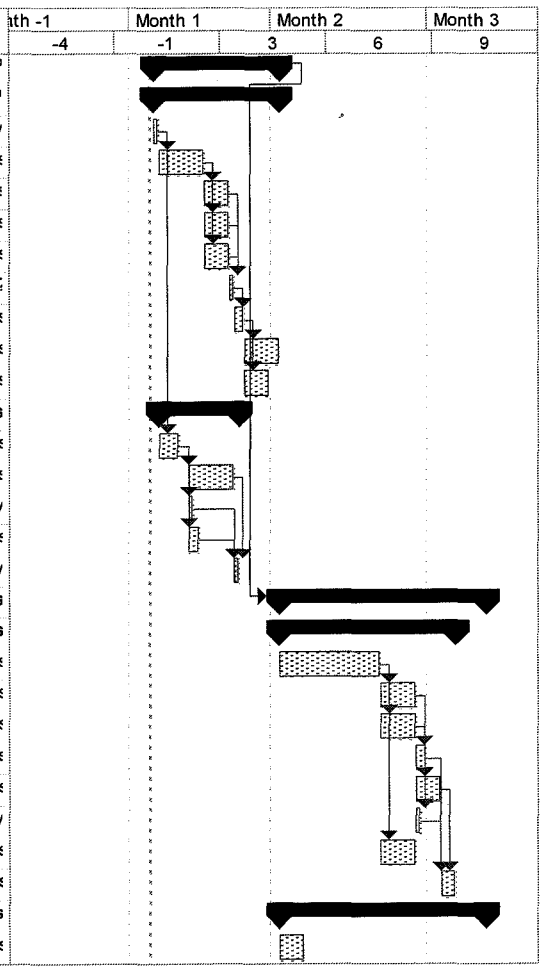

Figure 5(e) : Decision Tree in relation to service order provisioning

# APPENDIX B

# Appendix B

Figure 6 : Project Time Line of the prototype development

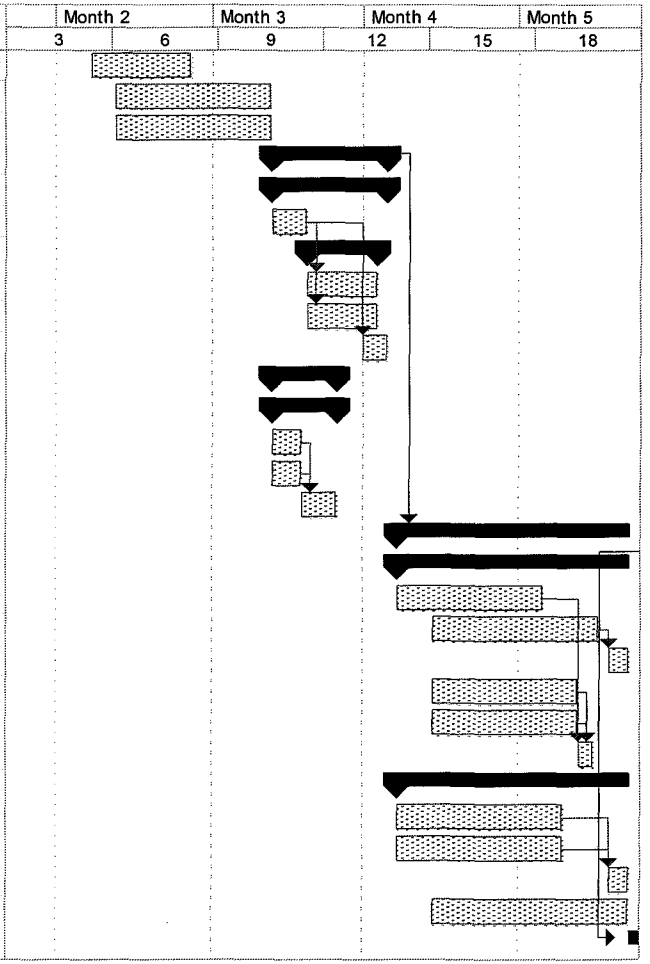
| ID | Task Name | Duration |
|---|---|---|
| 1 | **Planning** | **19 days?** |
| 2 | **To handle normal information system (IS) requirement (Traditional SDLC)** | **19 days?** |
| 3 | Make appointment of project team members and relevant resources | 1 day |
| 4 | To conduct technical, economical and commercial feasibility studies | 7 days |
| 5 | To produce the list of priorities of Systems and projects | 3 days |
| 6 | To produce the list of priorities of architecture for data, networks and physical hardware | 3 days |
| 7 | To produce the list of priorities of Information management activities based on the proposed systems | 3 days |
| 8 | To produce a high level functional business user requirement of the system | 1 day? |
| 9 | To produce detailed steps and work plan for the project implementation | 2 days |
| 10 | To produce a specification of system scope and planning | 5 days |
| 11 | To produce a high level specification of system requirements or features | 3 days |
| 12 | **To handle Tacit Knowledge (Evaluate current infrastructures - KMSLC)** | **12 days** |
| 13 | To conduct feasibility studies | 4 days |
| 14 | To identify the problem and produce the descriptions of the problems | 7 days |
| 15 | To produce statement of objectives | 1 day |
| 16 | To propose performance criteria | 2 days |
| 17 | To propose the strategic plan on how to handle the current situation | 1 day |
| 18 | **Analysis** | **29 days** |
| 19 | **To handle normal information system (IS) requirement (Traditional SDLC)** | **25 days** |
| 20 | To conduct interview with the users | 14 days |
| 21 | To produce descriptions of current system (CASS), and manual processes | 5 days |
| 22 | To produce detailed problem descriptions and opportunities | 5 days |
| 23 | To propose general recommendation and alternatives on how to fix the problem | 2 days |
| 24 | To propose general recommendation and alternatives on how to enhance functional capabilities of the ex | 3 days |
| 25 | To produce descriptions of the alternatives and relevant justification | 1 day |
| 26 | To produce detailed user requirement | 5 days |
| 27 | Sign-off the proposed specification and accepted user requirement | 3 days |
| 28 | **To handle the tacit knowledge (Capture the knowledge - KMSLC)** | **29 days** |
| 29 | Selection on the experts | 3 days |



# Appendix B

Figure 6 : Project Time Line of the prototype development

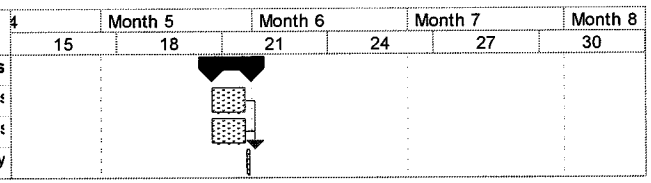
| ID | Task Name | Duration |
|---|---|---|
| 30 | To conduct the interview and brainstorm with experts and relevant personnel | 14 days |
| 31 | To produce the acquisition of knowledge core | 23 days |
| 32 | To produce the guidelines on how best to capture the tacit knowledge | 23 days |
| 33 | **Design** | **17 days** |
| 34 | **To handle normal information system (IS) requirement (Traditional SDLC)** | **17 days** |
| 35 | To produce functional, detailed specifications of all systems | 5 days |
| 36 | **To produce the logical design of the proposed system** | **10 days** |
| 37 | Data flow Diagram (DFD) | 10 days |
| 38 | Entity Relationship Diagram (E-R) | 10 days |
| 39 | To produce the physical design | 5 days |
| 40 | **To handle the tacit knowledge (Produce KM blueprint - KMSLC)** | **9 days** |
| 41 | **To propose the blueprint of KM system** | **9 days** |
| 42 | To produce the implementation details on software and hardware | 4 days |
| 43 | To produce the security, audit and operating procedures | 4 days |
| 44 | To propose the integration with on-going IS under development | 5 days |
| 45 | **Implementation** | **34 days** |
| 46 | **To handle normal information system (IS) requirement.(Traditional SDLC)** | **34 days** |
| 47 | To write the program coding | 21 days |
| 48 | To produce all relevant documentations | 25 days |
| 49 | To produce the guidelines and specifications for the training | 4 days |
| 50 | To conduct data migration procedures | 21 days |
| 51 | To conduct data cleaning procedures | 21 days |
| 52 | User Acceptance Test and Sign-off | 3 days |
| 53 | **To handle the tacit knowledge (Testing; Validation and Verification - KMSLC)** | **34 days** |
| 54 | To perform the validation testing | 25 days |
| 55 | To perform the verification testing | 25 days |
| 56 | User acceptance test and sign-off | 4 days |
| 57 | To produce the relevant documentation | 29 days |
| 58 | **Maintenance** | **6 days?** |



# Appendix B

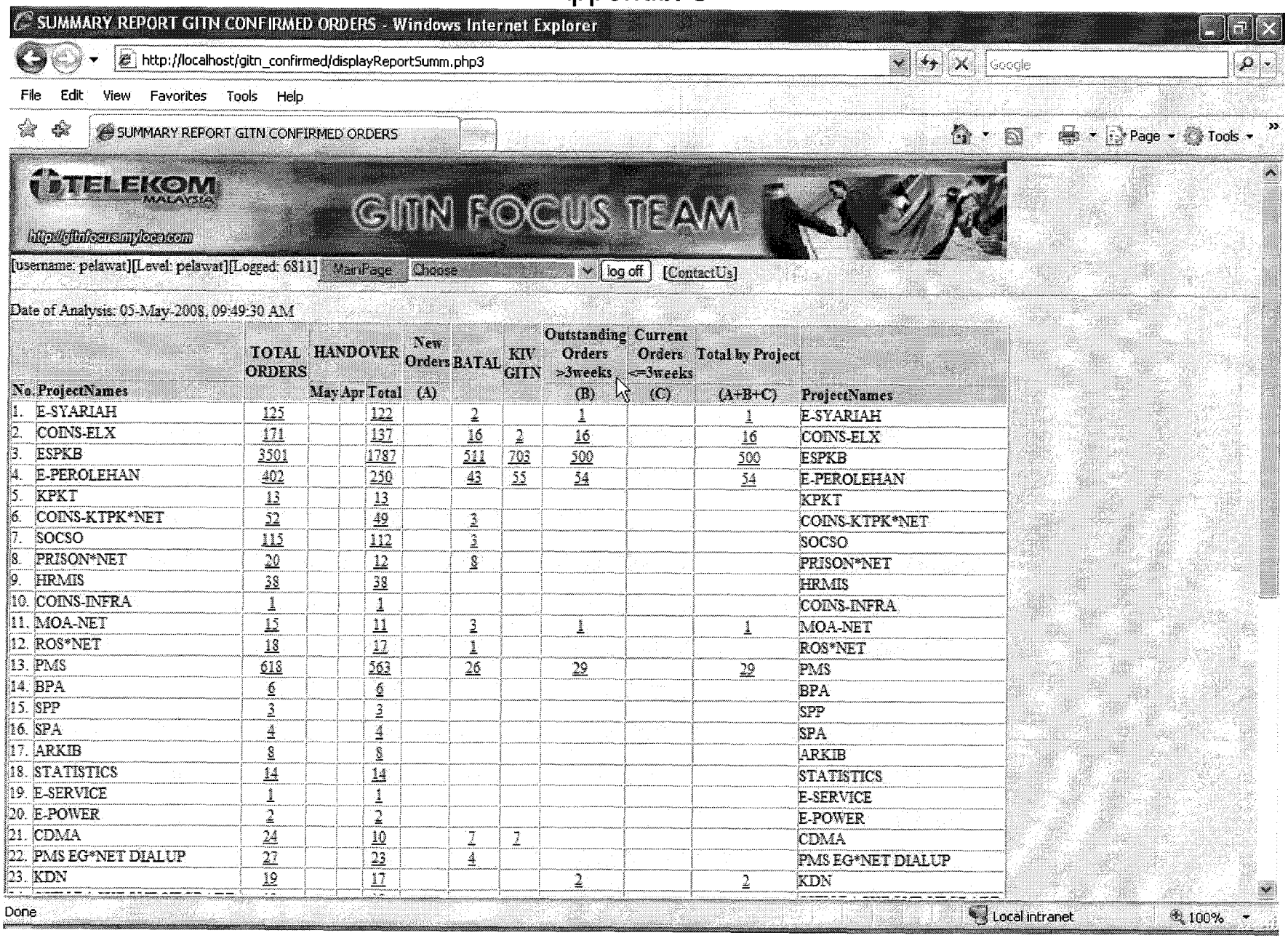
Figure 6 : Project Time Line of the prototype development

| ID | Task Name | Duration |
|---|---|---|
| 58 | **Maintenance** | **6 days** |
| 59 | To produce the guidelines and manuals on how to maintain during system operation. | 5 days |
| 60 | To conduct the post implementation review on the system development | 5 days |
| 61 | To hand over the complete system to the IT operation group | 1 day |



# APPENDIX C

# Appendix C

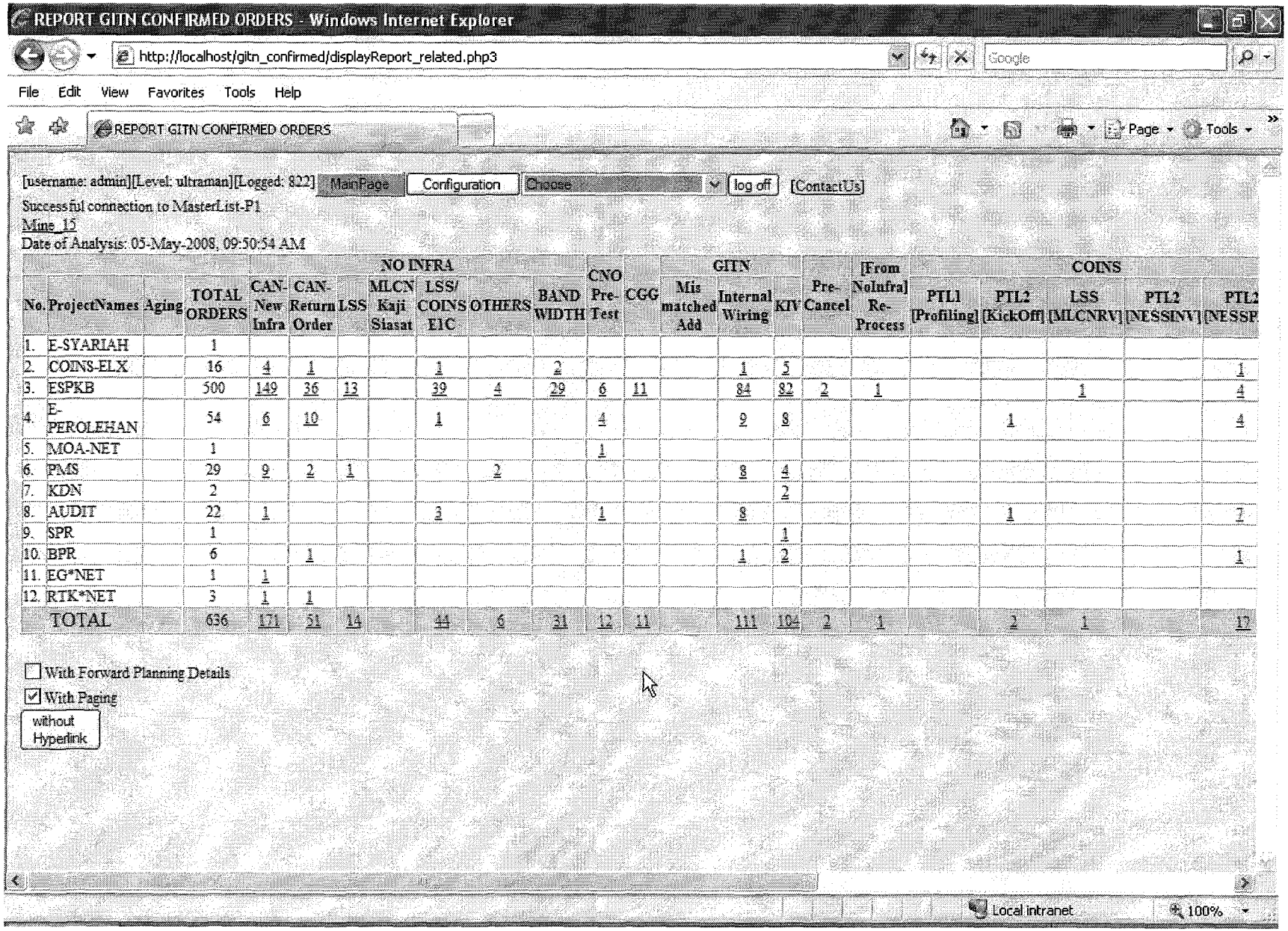



| No. | ProjectNames | TOTAL ORDERS | HANDOVER May | HANDOVER Apr | HANDOVER Total | New Orders (A) | BATAL | KIV GITN | Outstanding Orders >3weeks (B) | Current Orders <=3weeks (C) | Total by Project (A+B+C) | ProjectNames |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | E-SYARIAH | 125 | | | 122 | | 2 | | 1 | | 1 | E-SYARIAH |
| 2. | COINS-ELX | 171 | | | 137 | | 16 | 2 | 16 | | 16 | COINS-ELX |
| 3. | ESPKB | 3501 | | | 1787 | | 511 | 703 | 500 | | 500 | ESPKB |
| 4. | E-PEROLEHAN | 402 | | | 230 | | 43 | 55 | 54 | | 54 | E-PEROLEHAN |
| 5. | KPKT | 13 | | | 13 | | | | | | | KPKT |
| 6. | COINS-KTPK*NET | 52 | | | 49 | | 3 | | | | | COINS-KTPK*NET |
| 7. | SOCSO | 115 | | | 112 | | 3 | | | | | SOCSO |
| 8. | PRISON*NET | 20 | | | 12 | | 8 | | | | | PRISON*NET |
| 9. | HRMIS | 38 | | | 38 | | | | | | | HRMIS |
| 10. | COINS-INFRA | 1 | | | 1 | | | | | | | COINS-INFRA |
| 11. | MOA-NET | 15 | | | 11 | | 3 | | 1 | | 1 | MOA-NET |
| 12. | ROS*NET | 18 | | | 17 | | 1 | | | | | ROS*NET |
| 13. | PMS | 618 | | | 563 | | 26 | | 29 | | 29 | PMS |
| 14. | BPA | 6 | | | 6 | | | | | | | BPA |
| 15. | SPP | 3 | | | 3 | | | | | | | SPP |
| 16. | SPA | 4 | | | 4 | | | | | | | SPA |
| 17. | ARKIB | 8 | | | 8 | | | | | | | ARKIB |
| 18. | STATISTICS | 14 | | | 14 | | | | | | | STATISTICS |
| 19. | E-SERVICE | 1 | | | 1 | | | | | | | E-SERVICE |
| 20. | E-POWER | 2 | | | 2 | | | | | | | E-POWER |
| 21. | CDMA | 24 | | | 10 | | 7 | 7 | | | | CDMA |
| 22. | PMS EG*NET DIALUP | 27 | | | 23 | | 4 | | | | | PMS EG*NET DIALUP |
| 23. | KDN | 19 | | | 17 | | | | 2 | | 2 | KDN |



Figure 7 : Example of Real-Time status report : Status of Service Orders

# Appendix C




| No. | ProjectNames | Aging | TOTAL ORDERS | NO INFRA | | | | | | CNO Pre-Test | CGG | GITN | | | Pre-Cancel | [From NoInfra] Re-Process | COINS | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | CAN-New Infra | CAN-Return Order | LSS | MLCN Kaji Siasat | LSS/ COINS EIC | OTHERS | BAND WIDTH | | | Mismatched Add | Internal Wiring | KIV | | | PTL1 [Profiling] | PTL2 [KickOff] | LSS [MLCNRV] | PTL2 [NESSINV] | PTL2 [NESSP |
| 1. | E-SYARIAH | | 1 | | | | | | | | | | | | | | | | | | |
| 2. | COINS-ELX | | 16 | 4 | 1 | | | 1 | | 2 | | | | 1 | 5 | | | | | | 1 |
| 3. | ESPKB | | 500 | 149 | 36 | 13 | | 39 | 4 | 29 | 6 | 11 | | 84 | 82 | 2 | 1 | | | 1 | | 4 |
| 4. | E-PEROLEHAN | | 54 | 6 | 10 | | | 1 | | | 4 | | | 9 | 8 | | | | 1 | | | 4 |
| 5. | MOA-NET | | 1 | | | | | | | | 1 | | | | | | | | | | | |
| 6. | PMS | | 29 | 9 | 2 | 1 | | | 2 | | | | | 8 | 4 | | | | | | | |
| 7. | KDN | | 2 | | | | | | | | | | | | 2 | | | | | | | |
| 8. | AUDIT | | 22 | 1 | | | | 3 | | | 1 | | | 8 | | | | | 1 | | | 7 |
| 9. | SPR | | 1 | | | | | | | | | | | | 1 | | | | | | | |
| 10. | BPR | | 6 | | 1 | | | | | | | | | 1 | 2 | | | | | | | 1 |
| 11. | EG*NET | | 1 | 1 | | | | | | | | | | | | | | | | | | |
| 12. | RTK*NET | | 3 | 1 | 1 | | | | | | | | | | | | | | | | | |
| | TOTAL | | 636 | 171 | 51 | 14 | | 44 | 6 | 31 | 12 | 11 | | 111 | 104 | 2 | 1 | | 2 | 1 | | 17 |



Figure 8 : Example of Real-Time status report : Based on Baskets

# APPENDIX D

Appendix D

# Page-by-page view of the knowledge based prototype

Figure 9 : Page-by-page view of the prototype

Appendix D


Figure 9 : Page-by-page view of the prototype

Appendix D

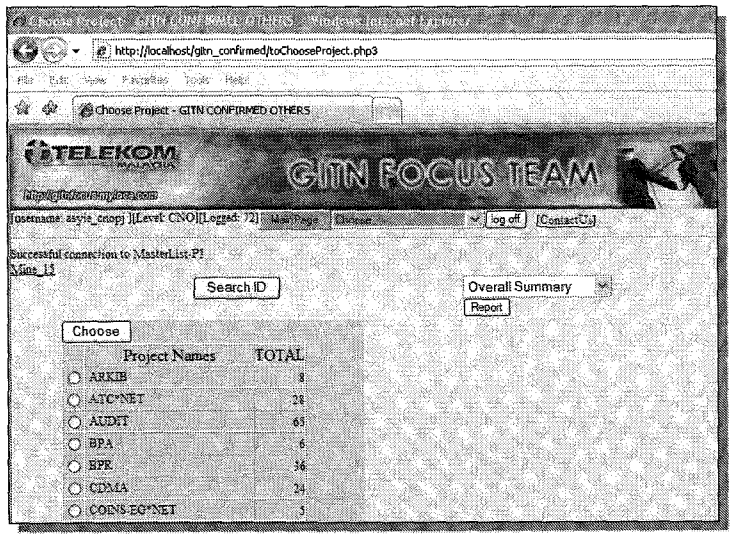



Figure 9 : Page-by-page view of the prototype

Appendix D

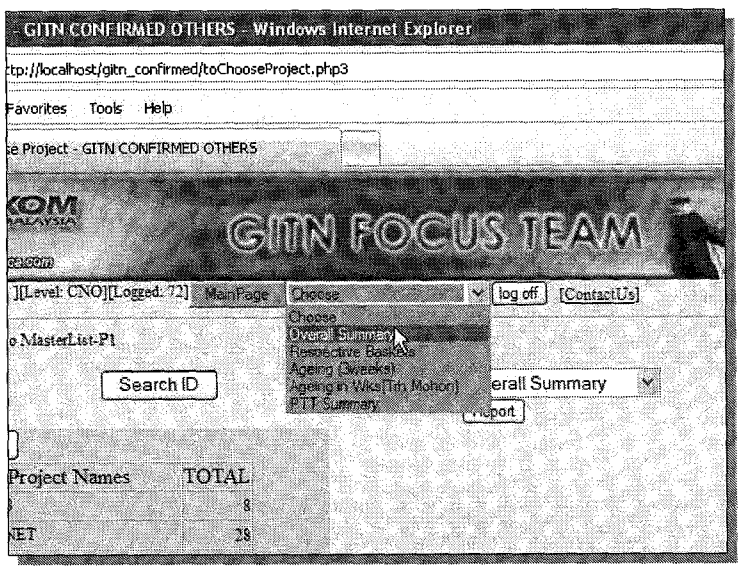



Figure 9 : Page-by-page view of the prototype

Appendix D

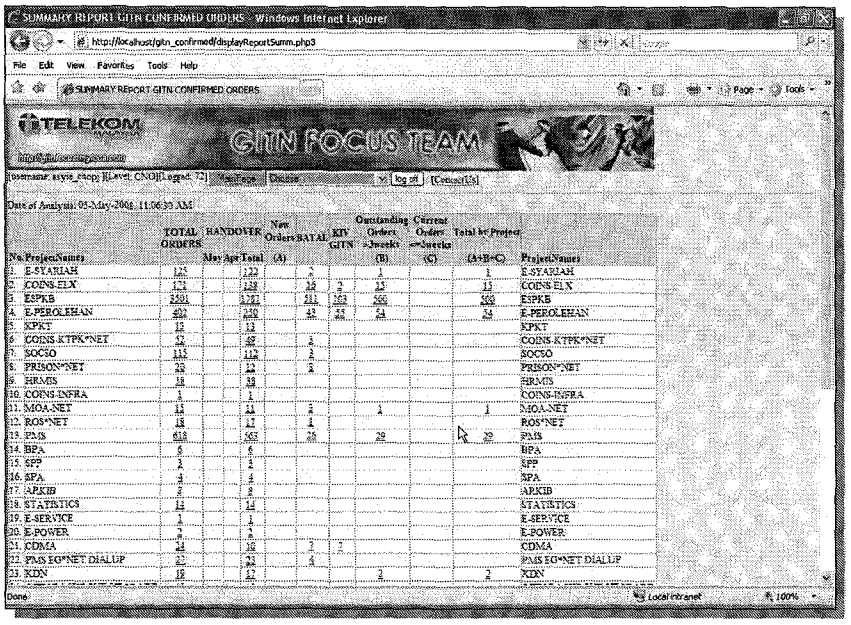



Figure 9 : Page-by-page view of the prototype

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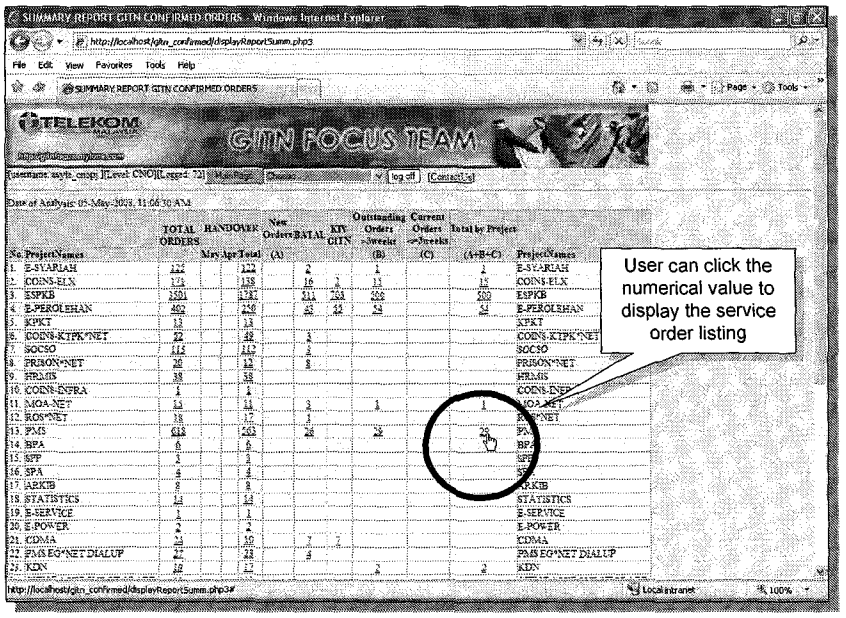


Figure 9 : Page-by-page view of the prototype

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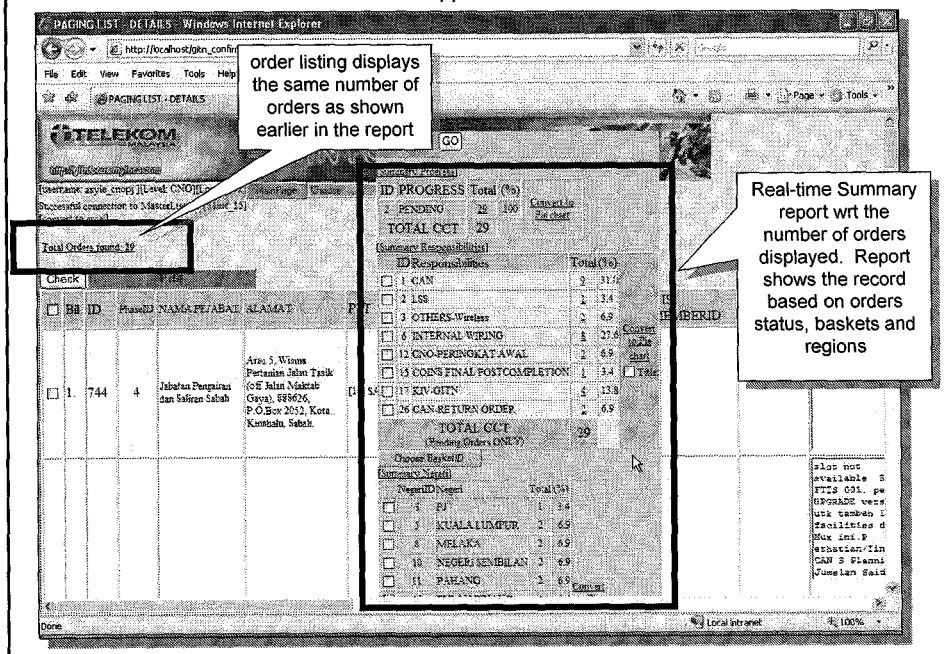


Figure 9 : Page-by-page view of the prototype

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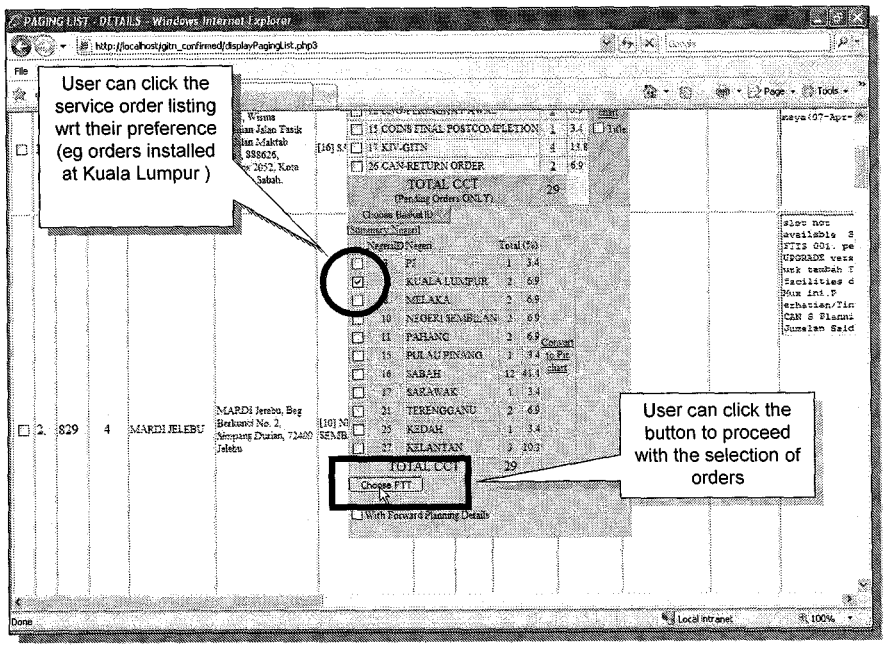


Figure 9 : Page-by-page view of the prototype

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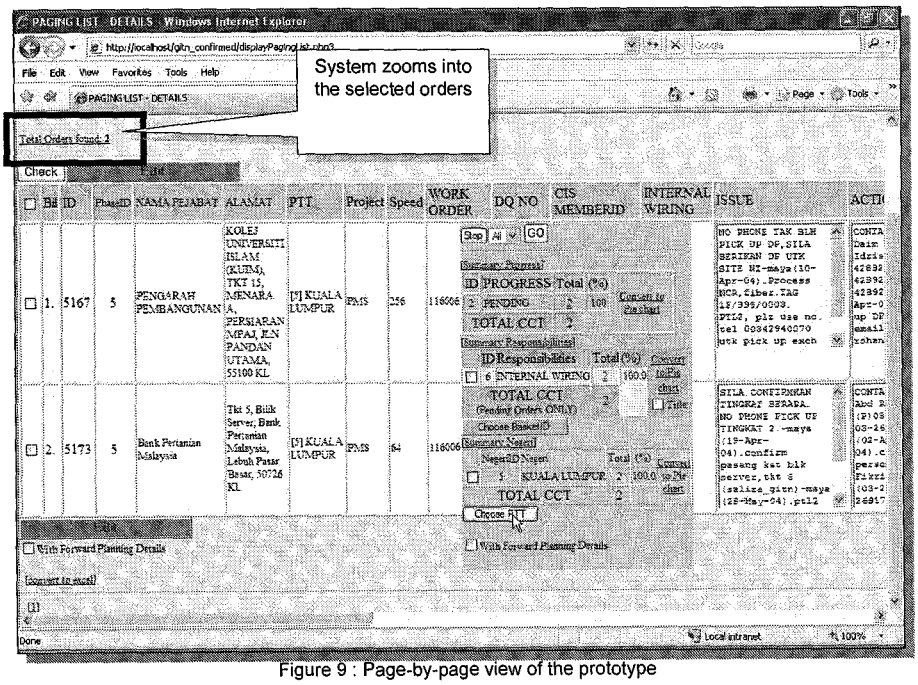


Figure 9 : Page-by-page view of the prototype

Appendix D

# Tracking & Monitoring capabilities

Figure 9 : Page-by-page view of the prototype

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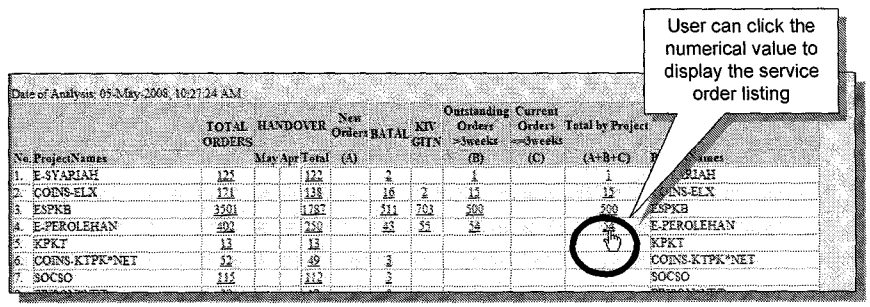


Figure 9 : Page-by-page view of the prototype

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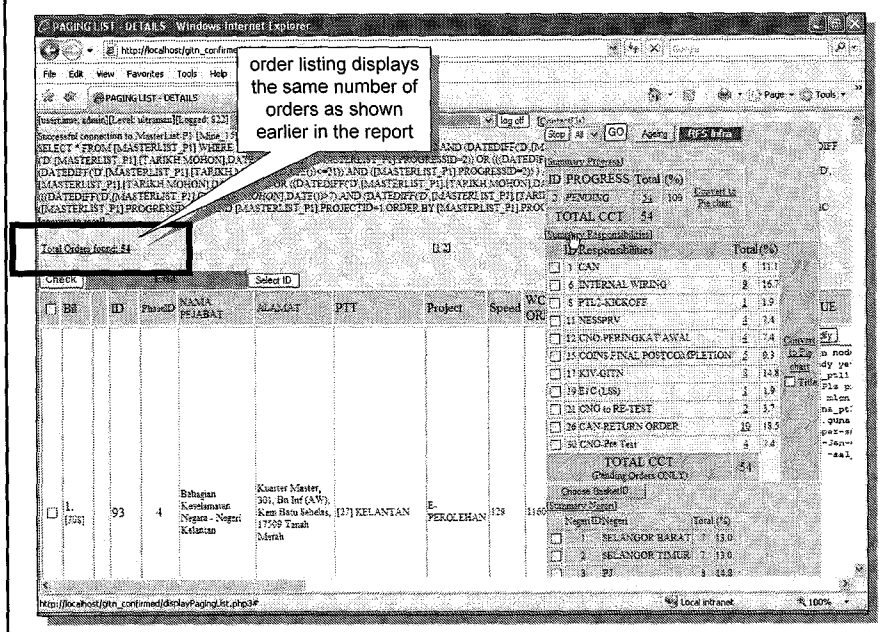


Figure 9 : Page-by-page view of the prototype

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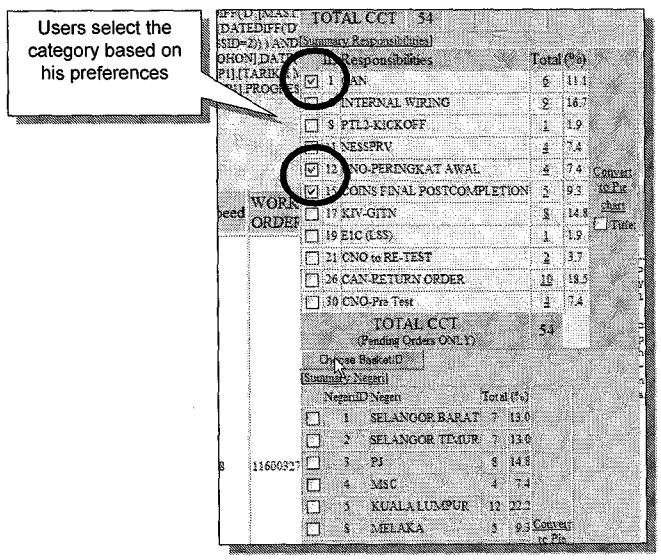


Figure 9 : Page-by-page view of the prototype

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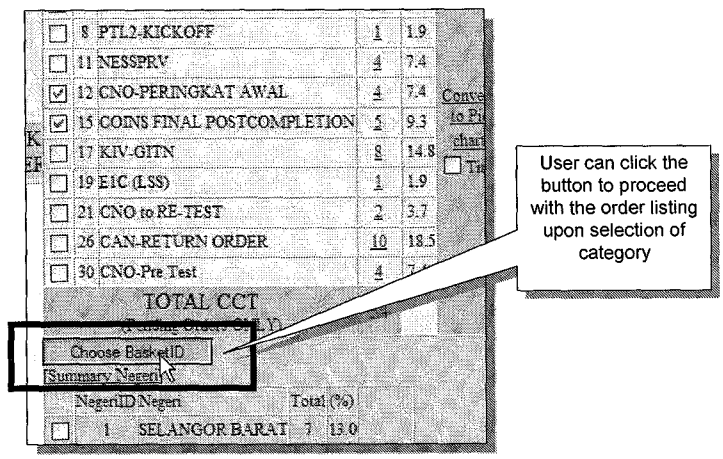


Figure 9 : Page-by-page view of the prototype

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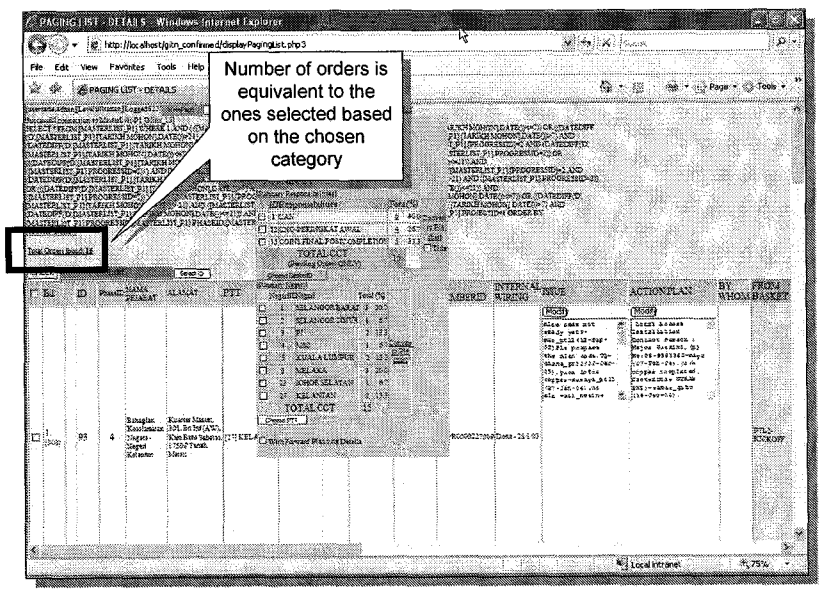


Figure 9 : Page-by-page view of the prototype

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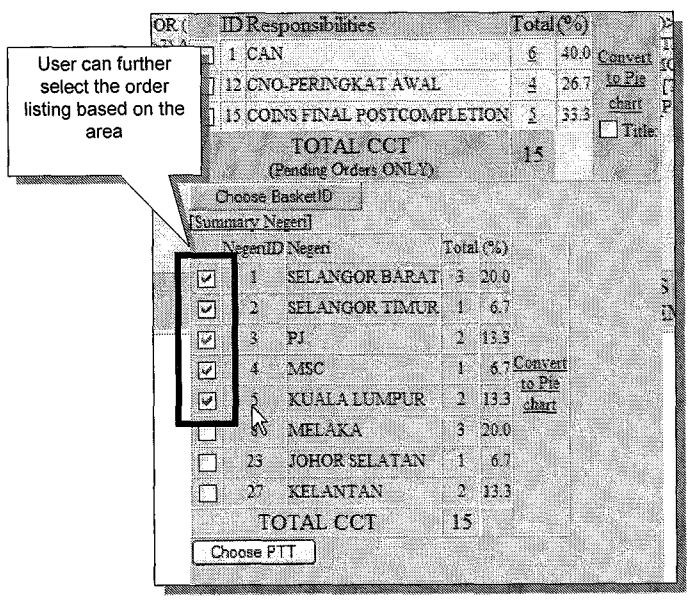


Figure 9 : Page-by-page view of the prototype

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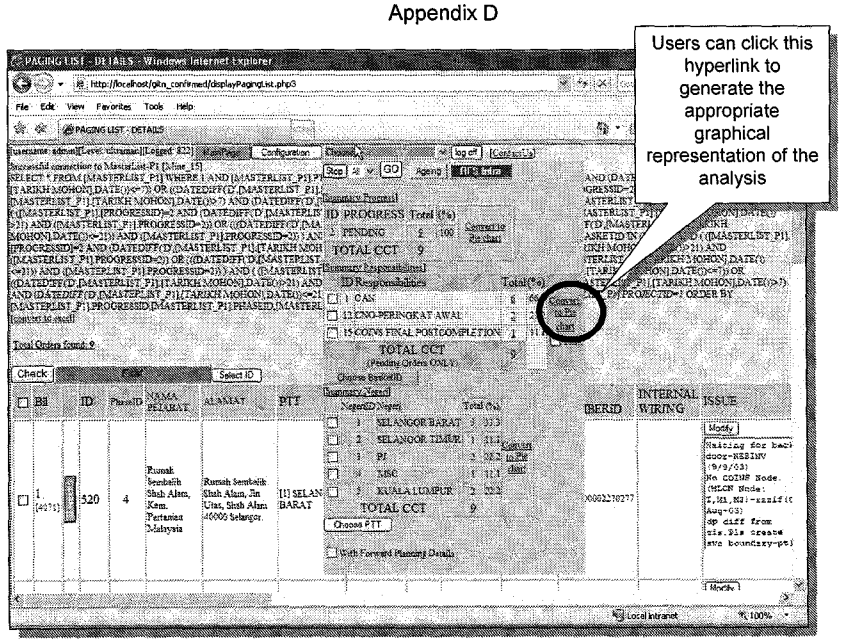


Figure 9 : Page-by-page view of the prototype

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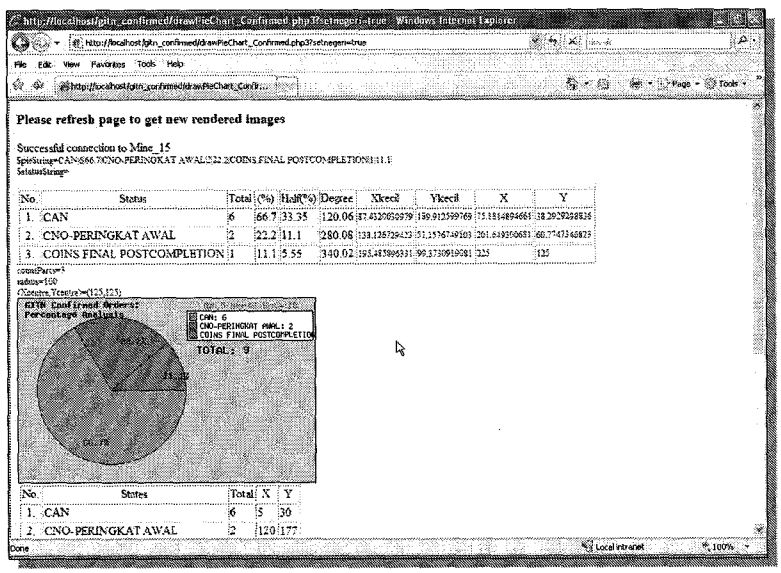


Figure 9 : Page-by-page view of the prototype

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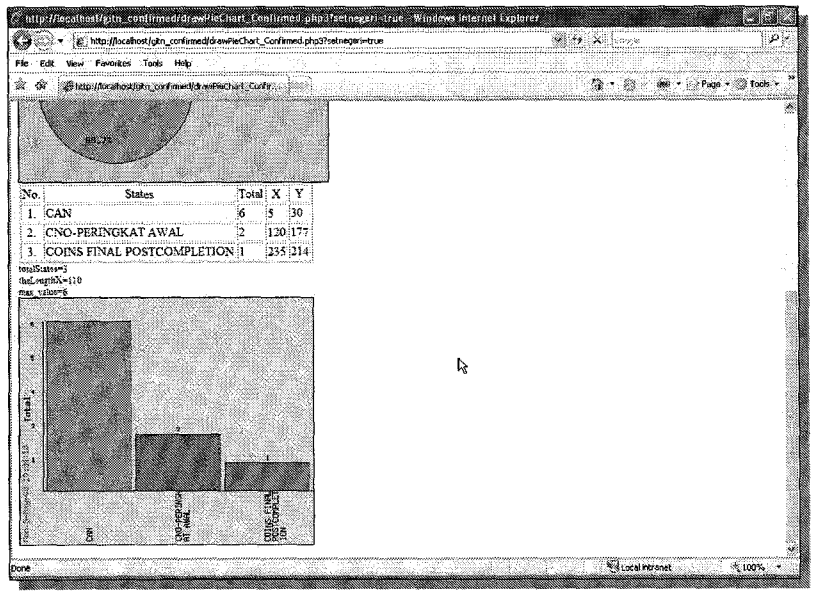


Figure 9 : Page-by-page view of the prototype

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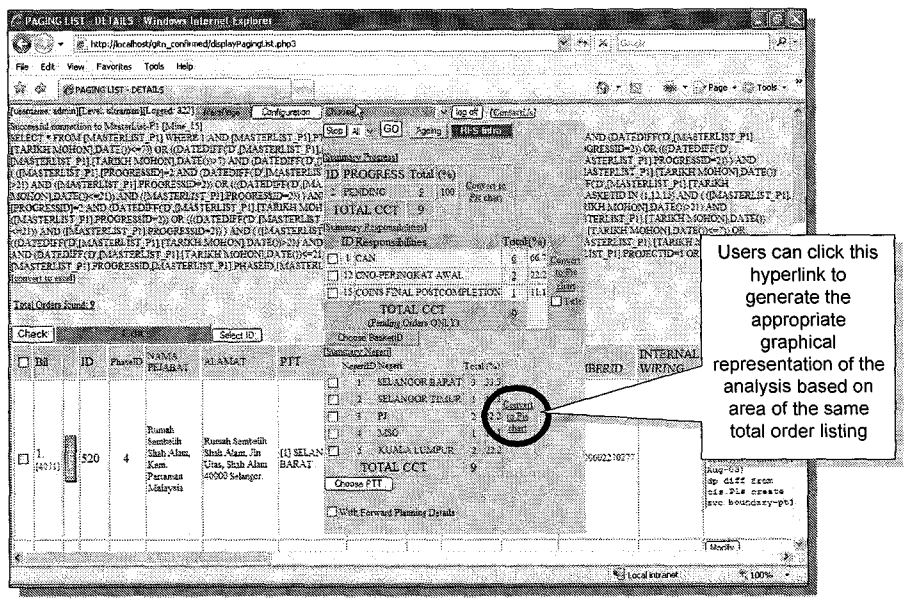


Figure 9 : Page-by-page view of the prototype

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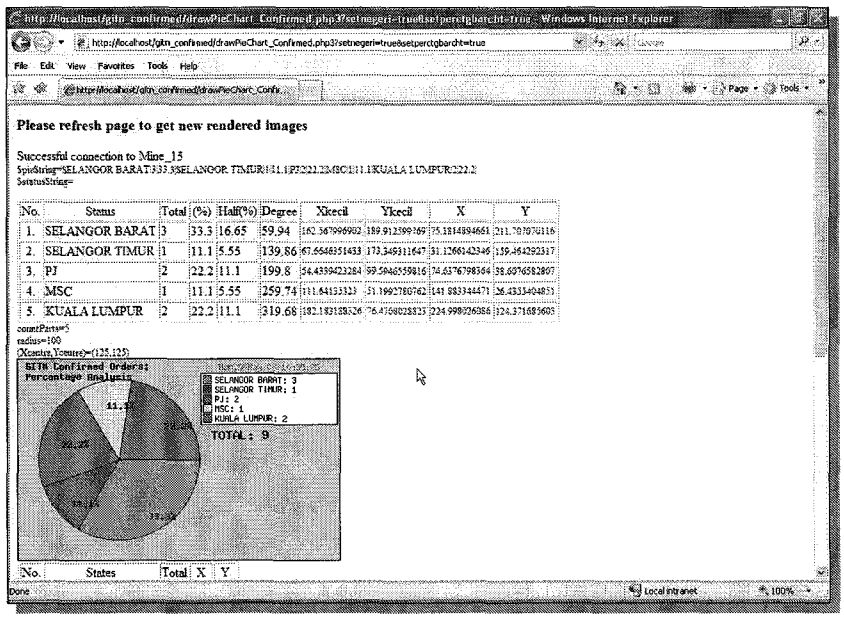


Figure 9 : Page-by-page view of the prototype

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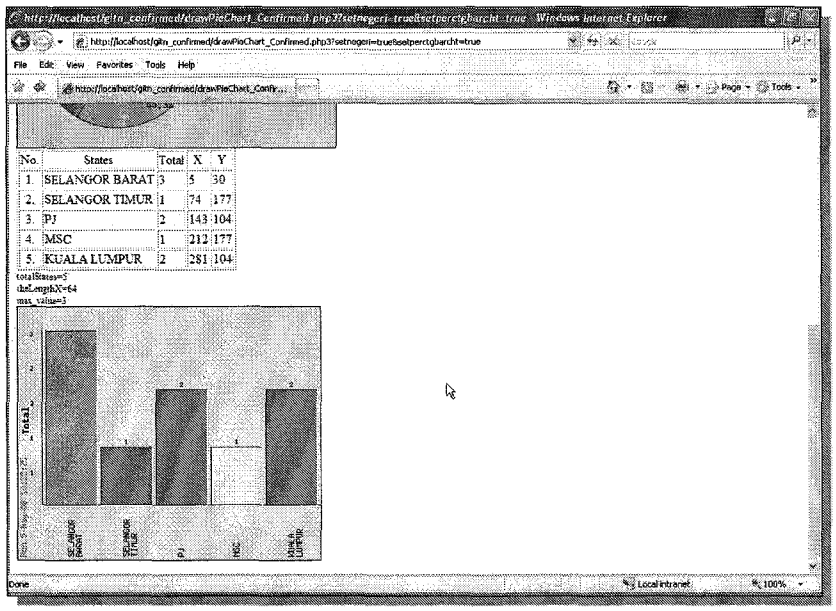

Figure 9 : Page-by-page view of the prototype

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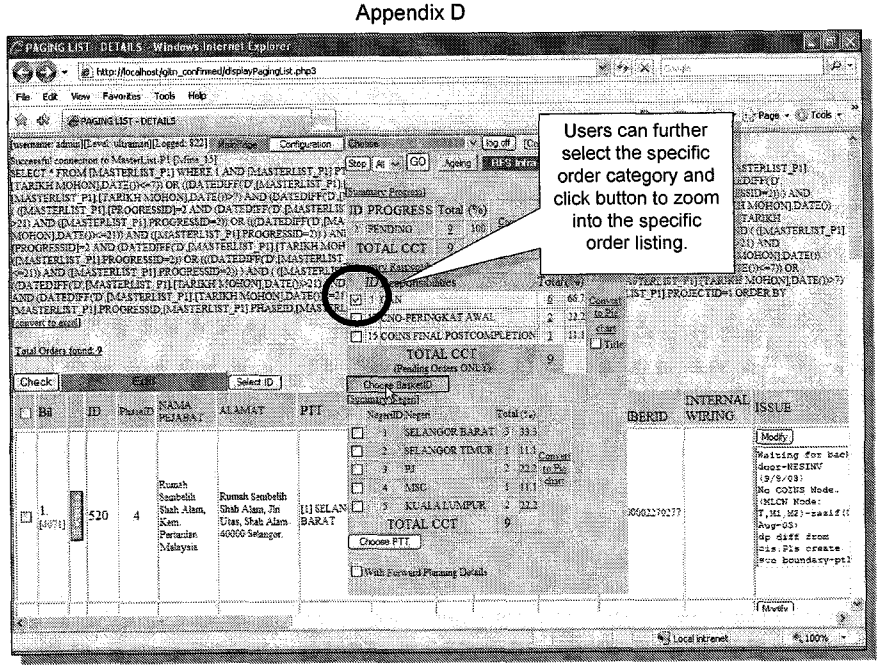


Figure 9 : Page-by-page view of the prototype

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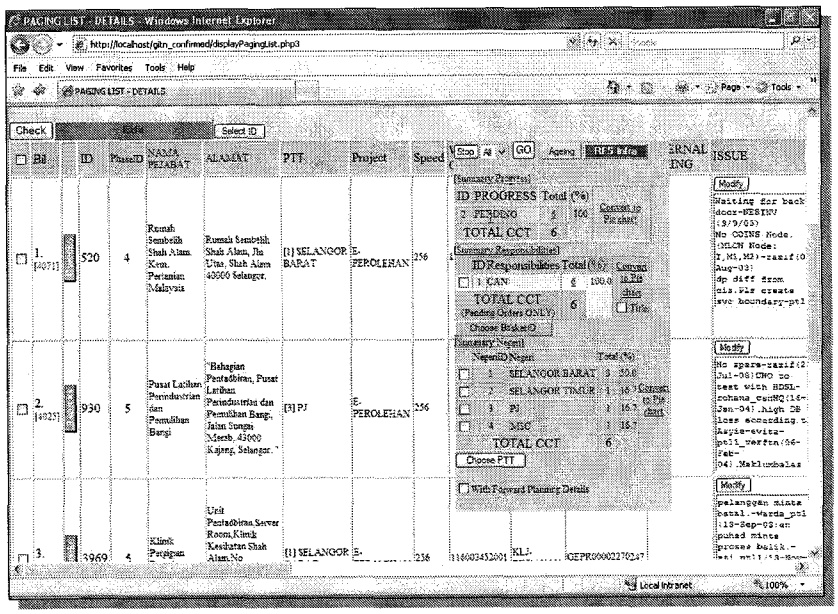


Figure 9 : Page-by-page view of the prototype

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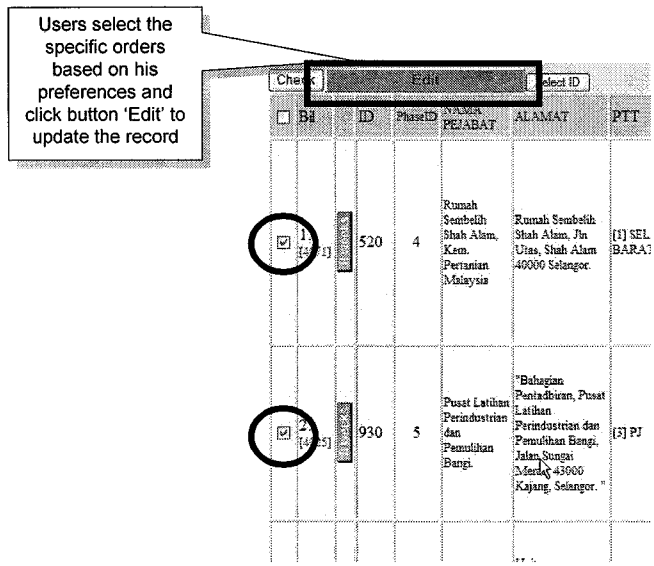


Figure 9 : Page-by-page view of the prototype

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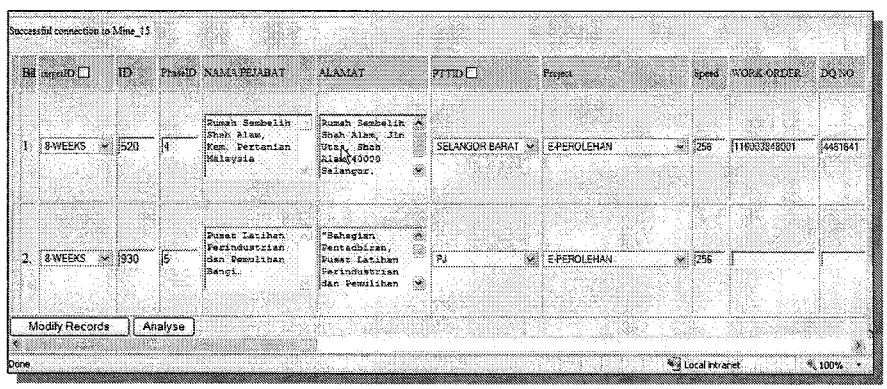


Figure 9 : Page-by-page view of the prototype

Appendix D

# Updating & Modifying Service Order Status

Figure 9 : Page-by-page view of the prototype

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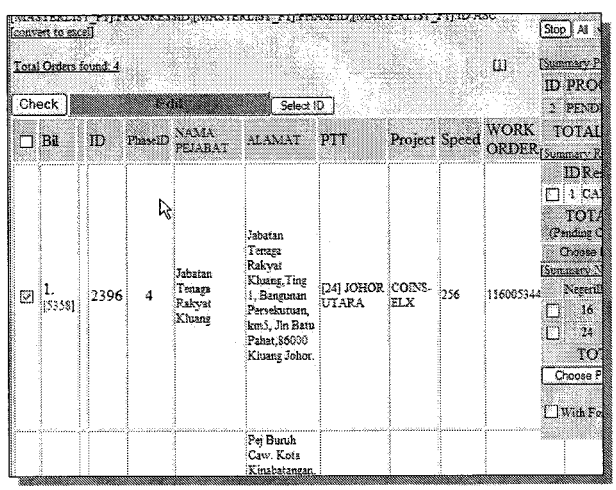


Figure 9 : Page-by-page view of the prototype

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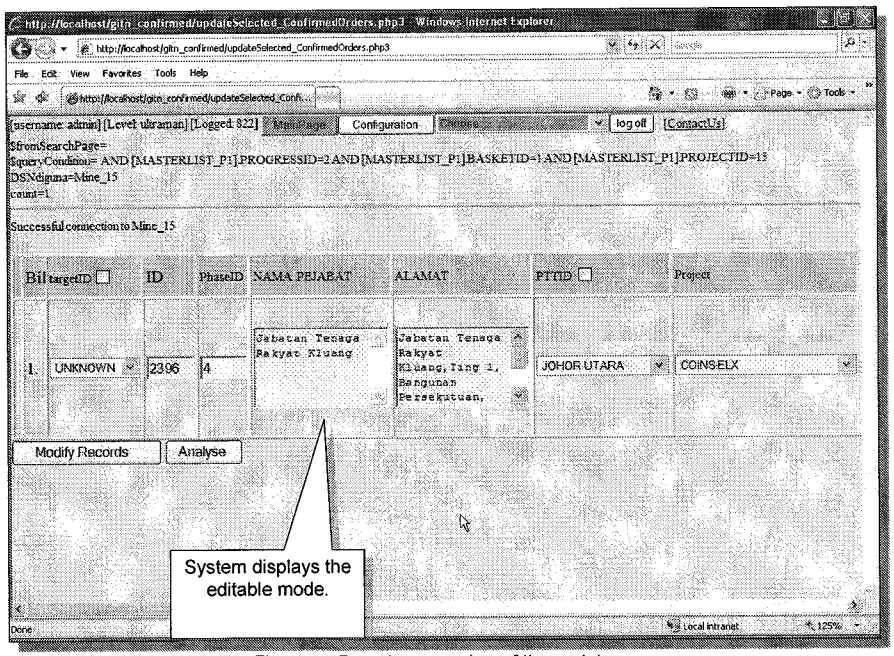


Figure 9 : Page-by-page view of the prototype

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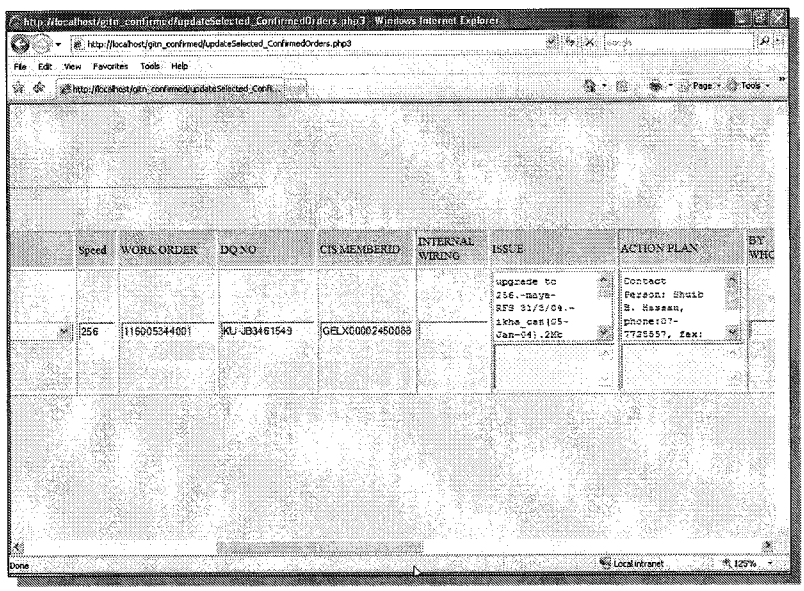

Figure 9 : Page-by-page view of the prototype

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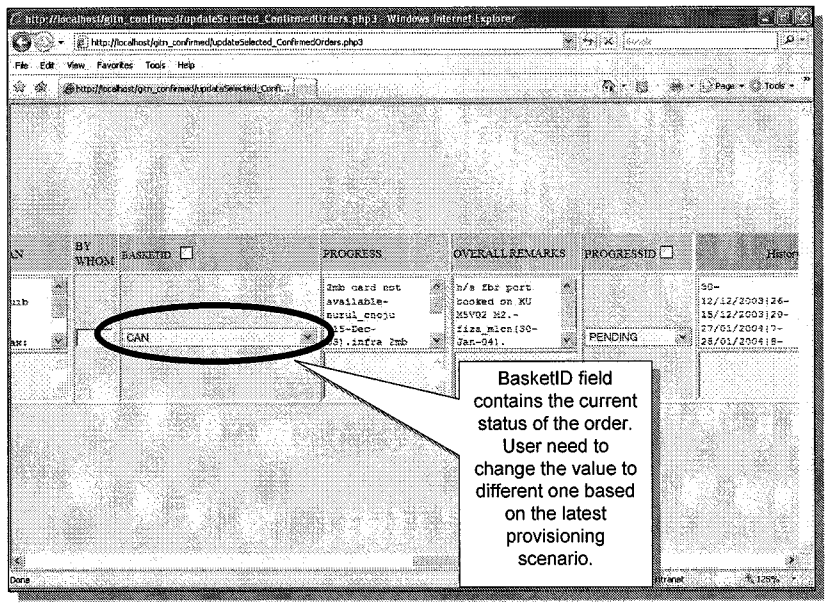


Figure 9 : Page-by-page view of the prototype

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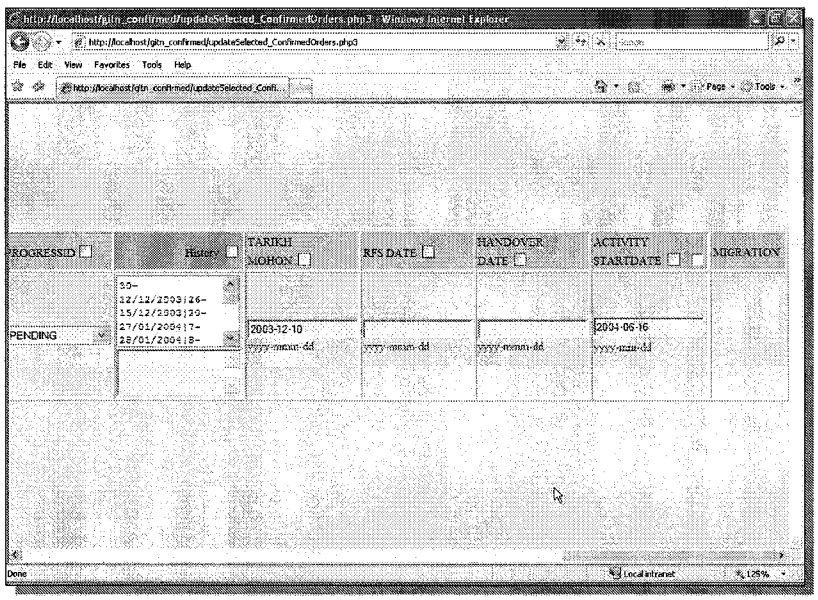


Figure 9 : Page-by-page view of the prototype

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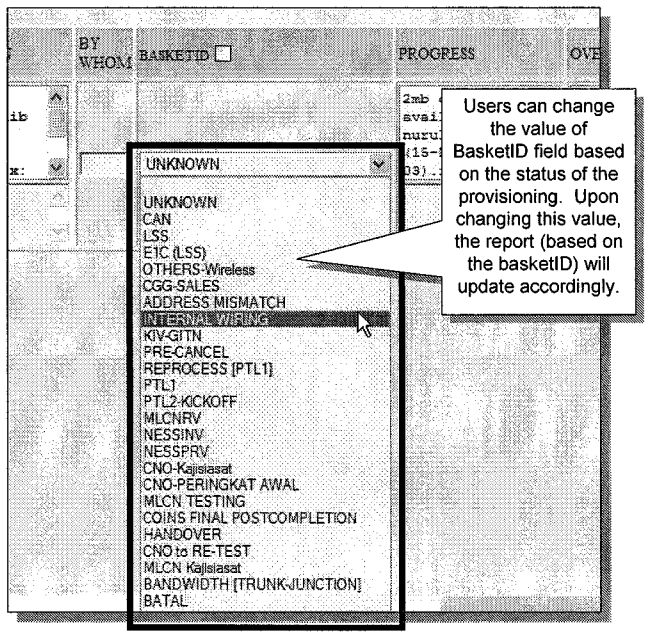


Figure 9 : Page-by-page view of the prototype

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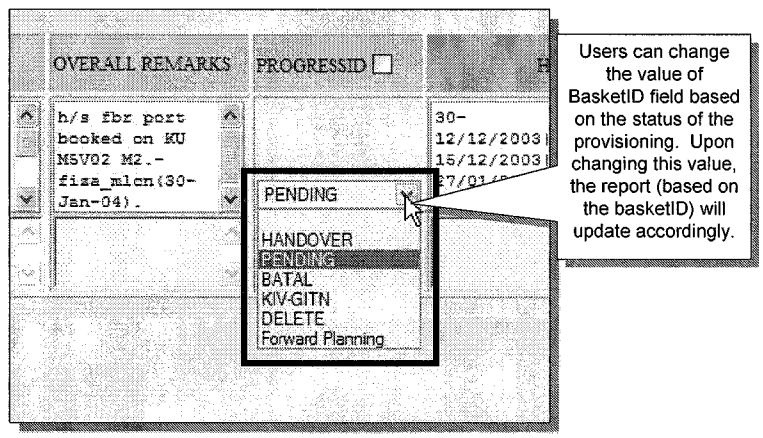


Figure 9 : Page-by-page view of the prototype

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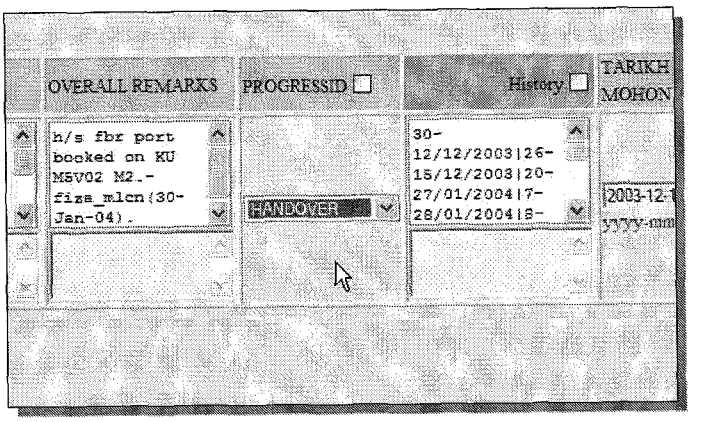


Figure 9 : Page-by-page view of the prototype

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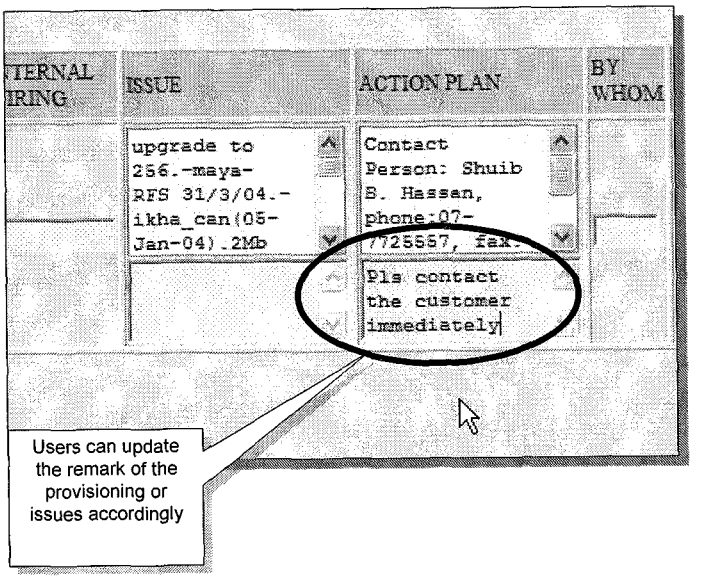


Figure 9 : Page-by-page view of the prototype

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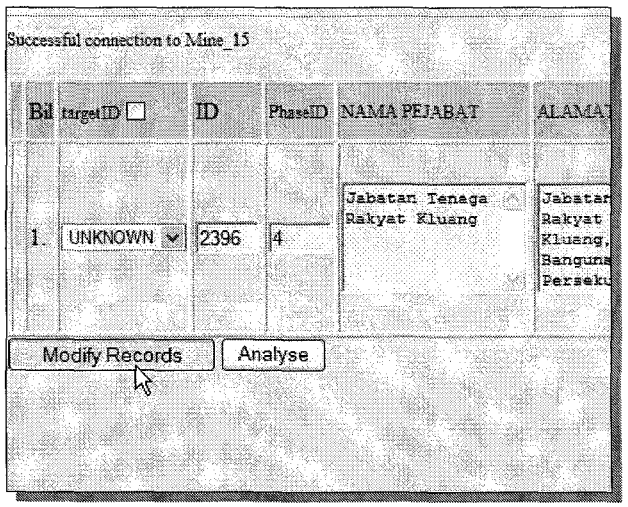


Figure 9 : Page-by-page view of the prototype

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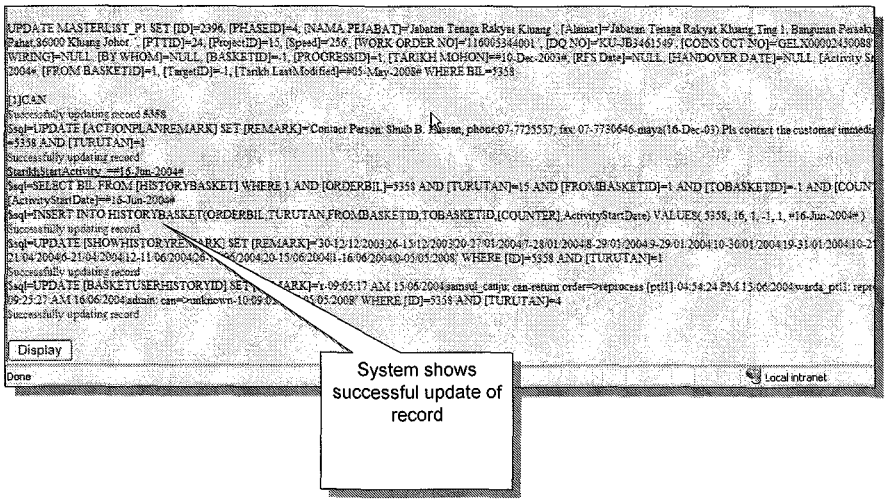


Figure 9 : Page-by-page view of the prototype

Appendix D

# Searching Functionalities

Figure 9 : Page-by-page view of the prototype

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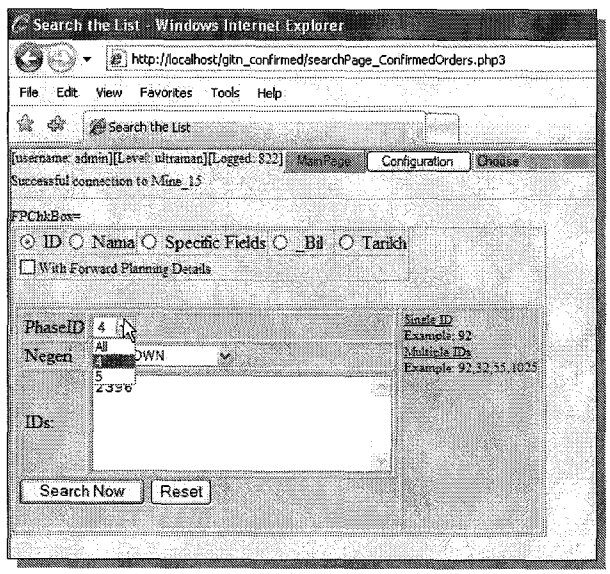


Figure 9 : Page-by-page view of the prototype

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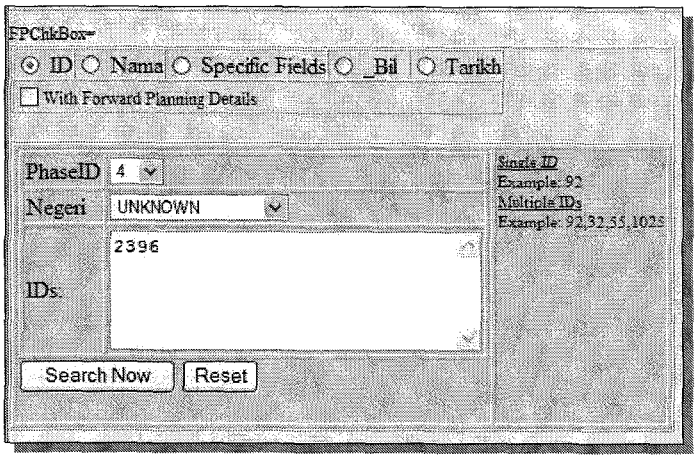


Figure 9 : Page-by-page view of the prototype

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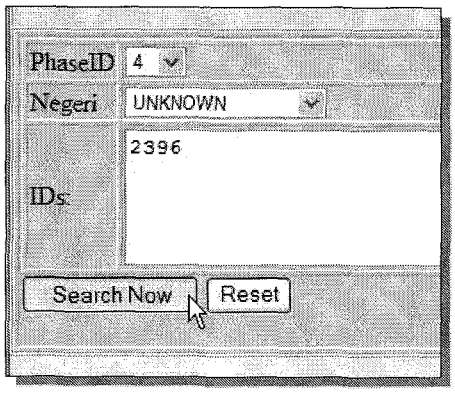


Figure 9 : Page-by-page view of the prototype

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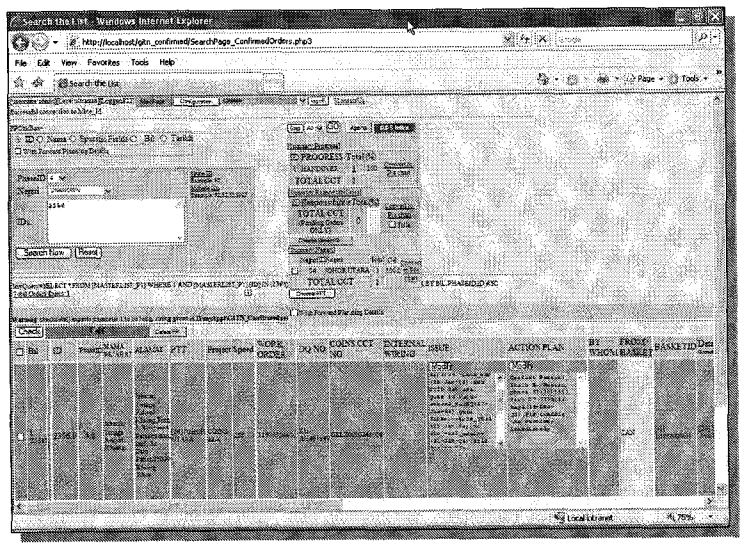

Figure 9 : Page-by-page view of the prototype

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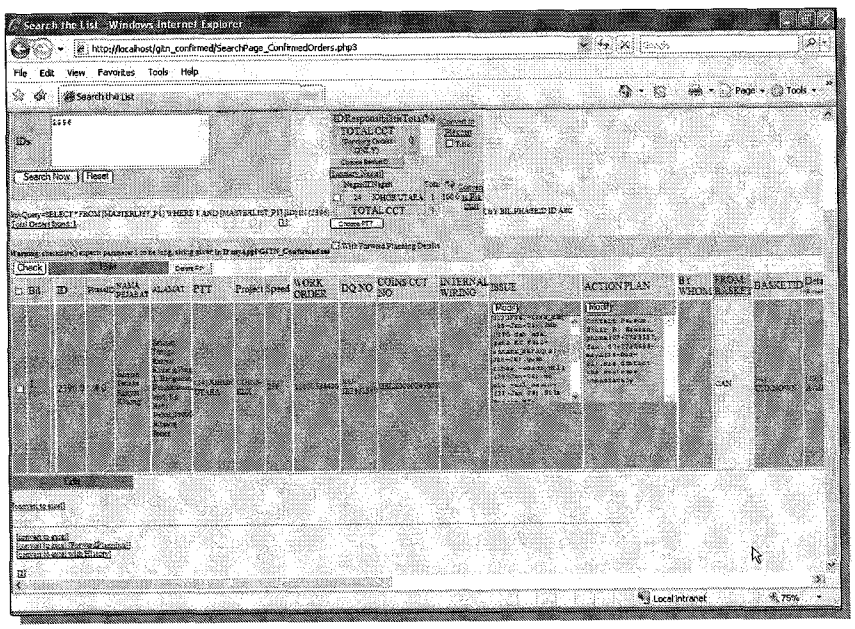

Figure 9 : Page-by-page view of the prototype

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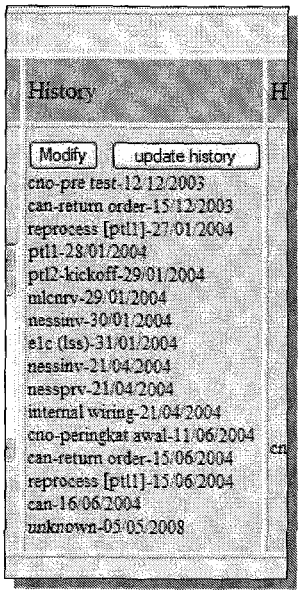


Figure 9 : Page-by-page view of the prototype

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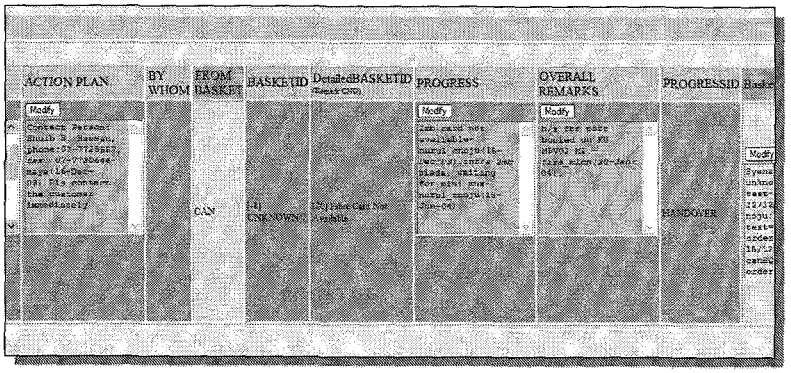


Figure 9 : Page-by-page view of the prototype

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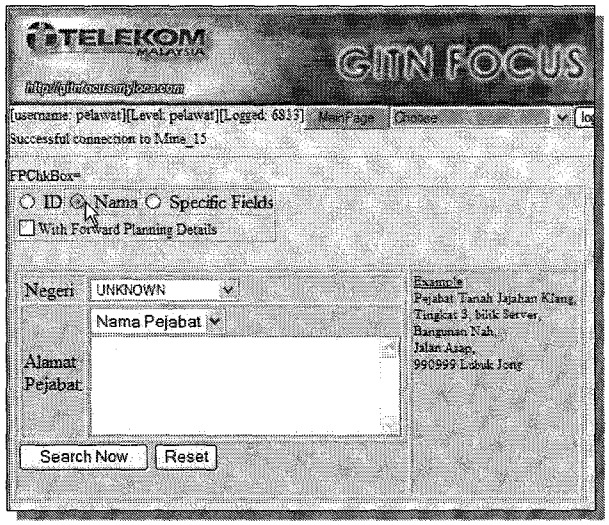


Figure 9 : Page-by-page view of the prototype

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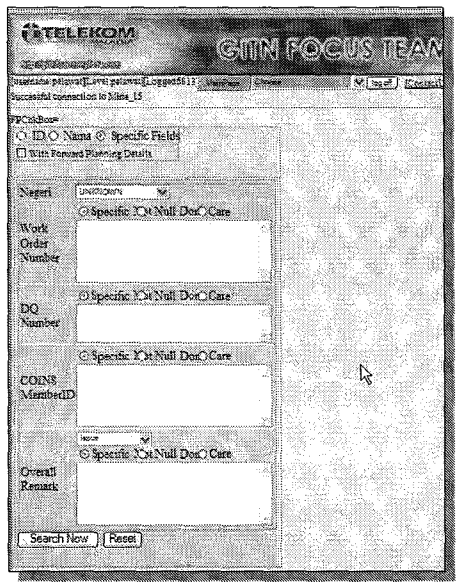


Figure 9 : Page-by-page view of the prototype

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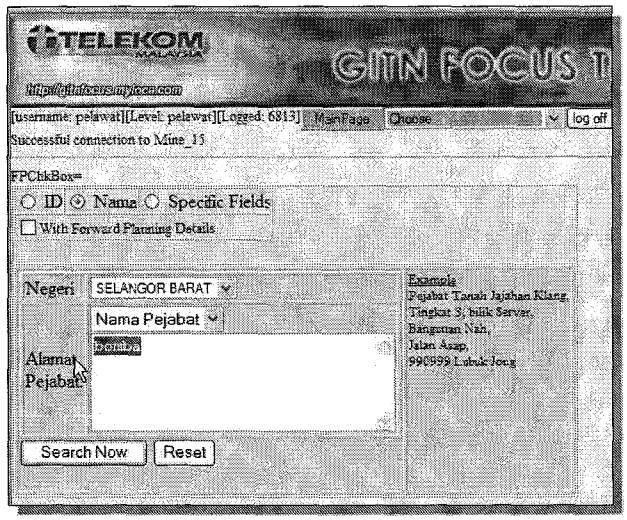


Figure 9 : Page-by-page view of the prototype

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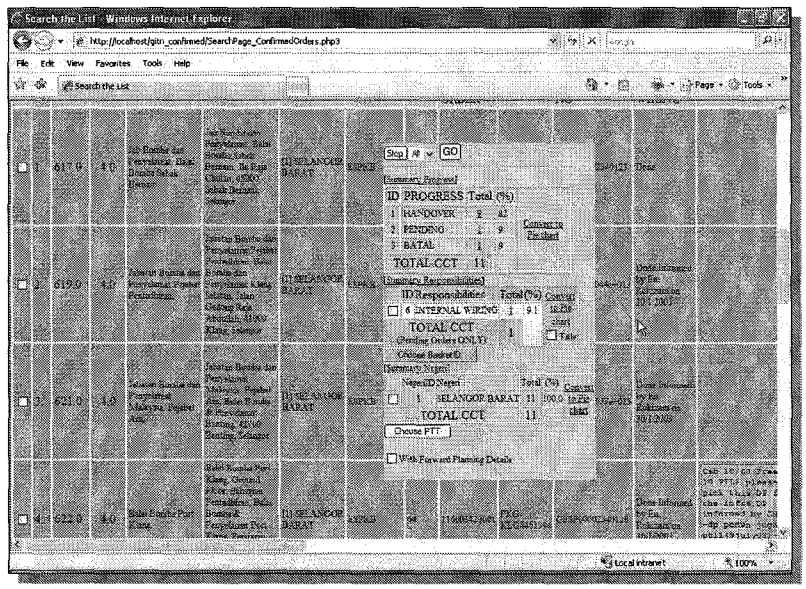


Figure 9 : Page-by-page view of the prototype

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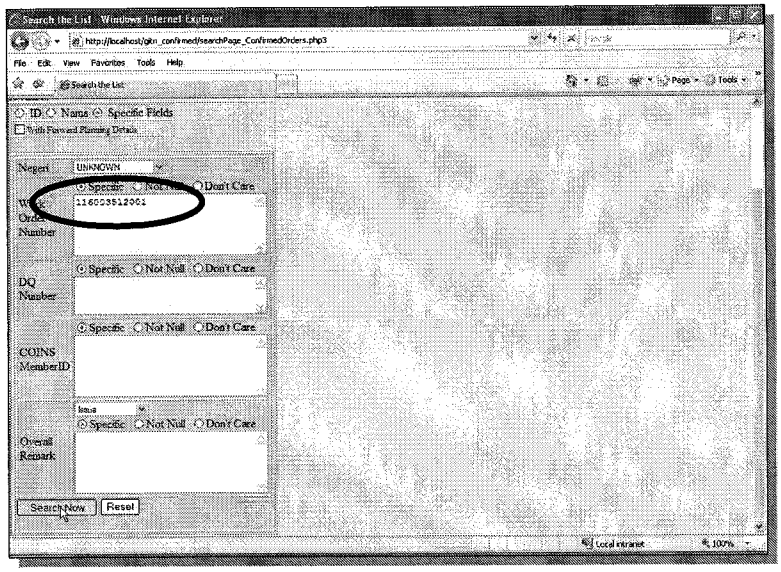


Figure 9 : Page-by-page view of the prototype

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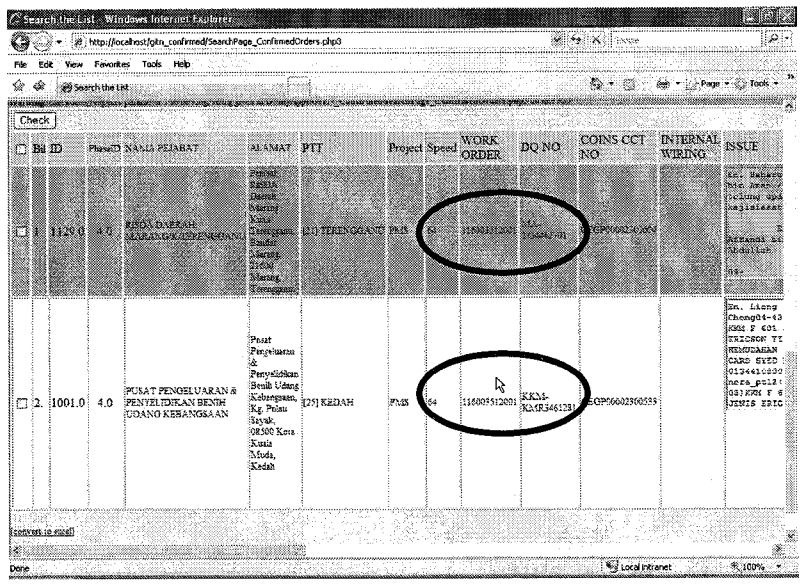


Figure 9 : Page-by-page view of the prototype

Appendix D

# Adding New Records

Figure 9 : Page-by-page view of the prototype

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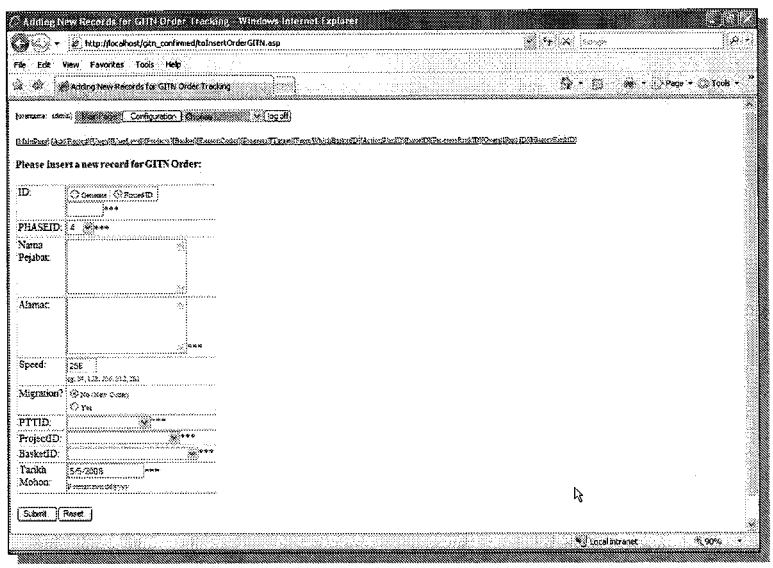


Figure 9 : Page-by-page view of the prototype

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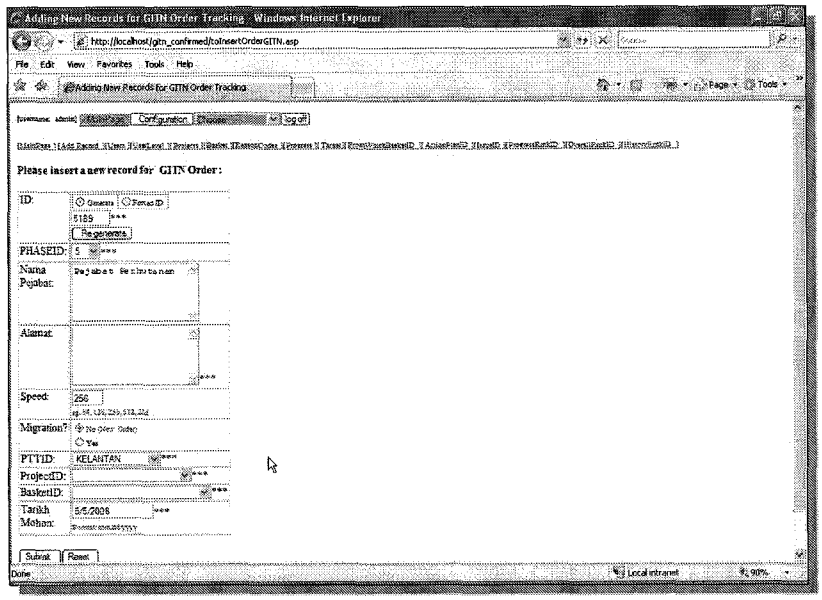


Figure 9 : Page-by-page view of the prototype

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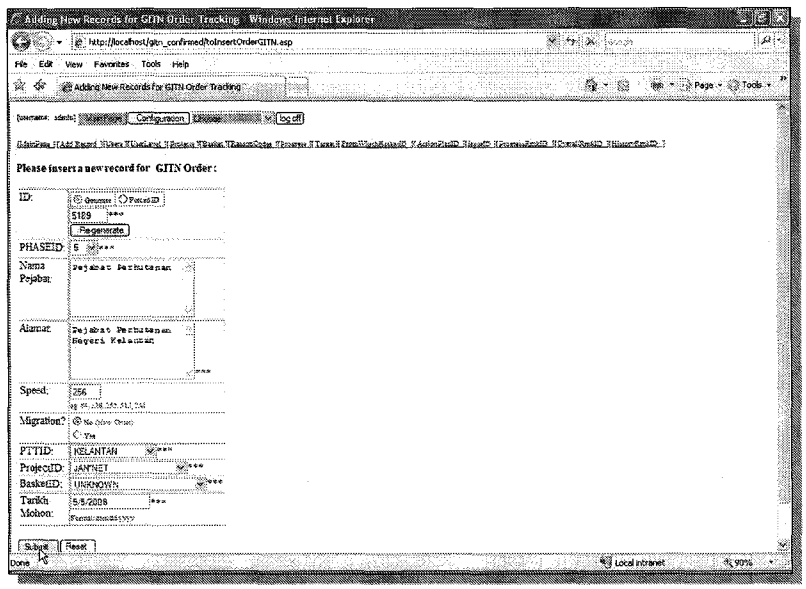


Figure 9 : Page-by-page view of the prototype

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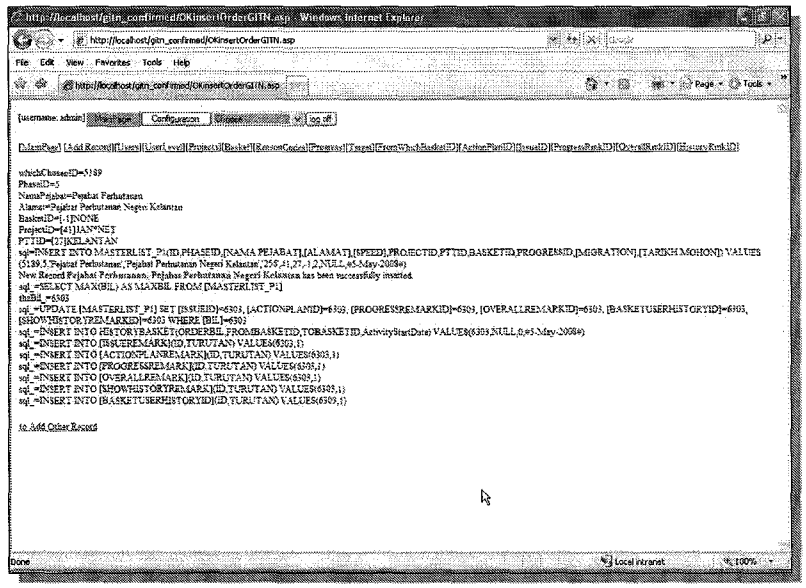


Figure 9 : Page-by-page view of the prototype

Appendix D

# Reason of codes containing the specific tacit knowledge unit

Figure 9 : Page-by-page view of the prototype

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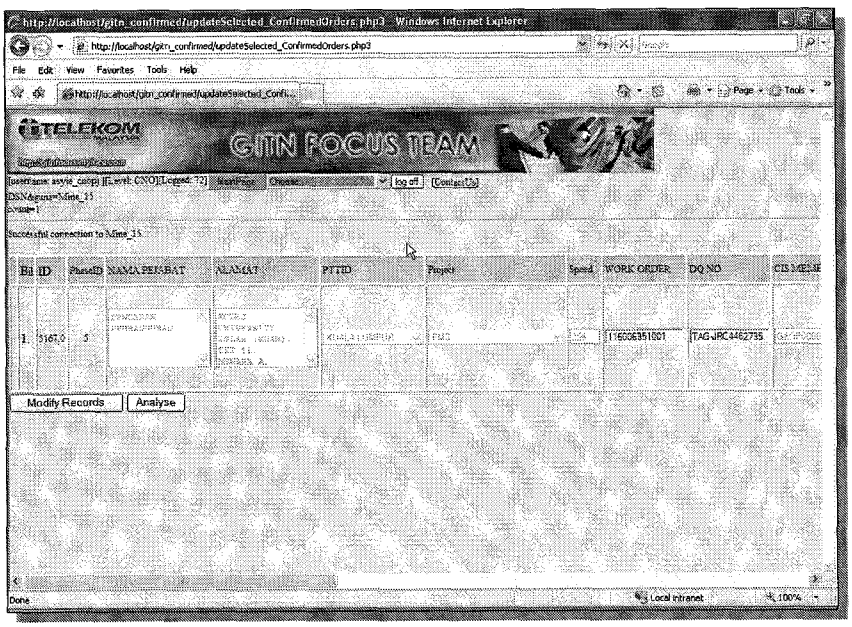


Figure 9 : Page-by-page view of the prototype

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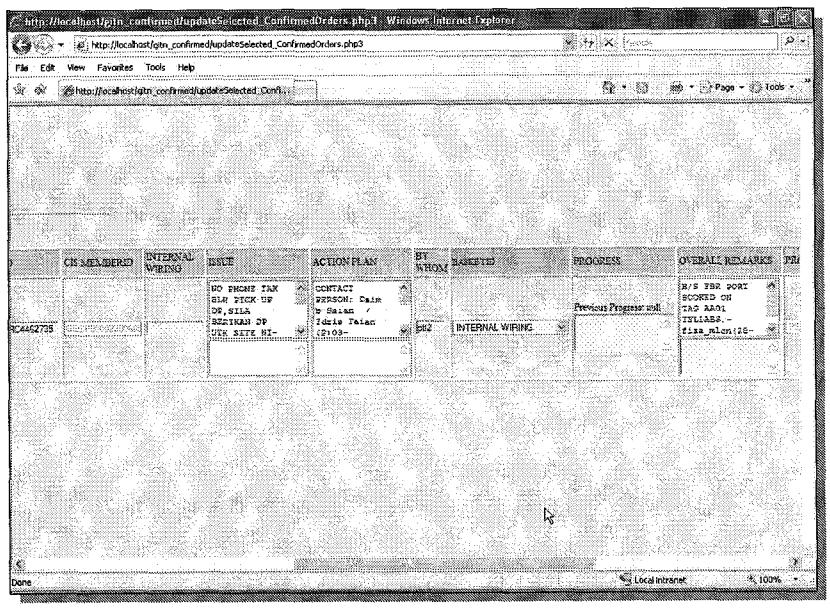


Figure 9 : Page-by-page view of the prototype

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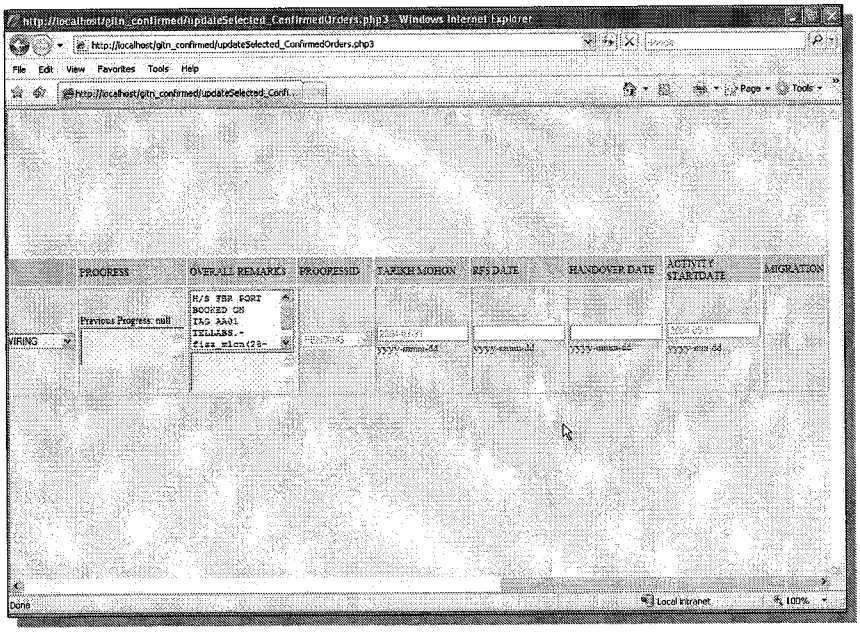


Figure 9 : Page-by-page view of the prototype

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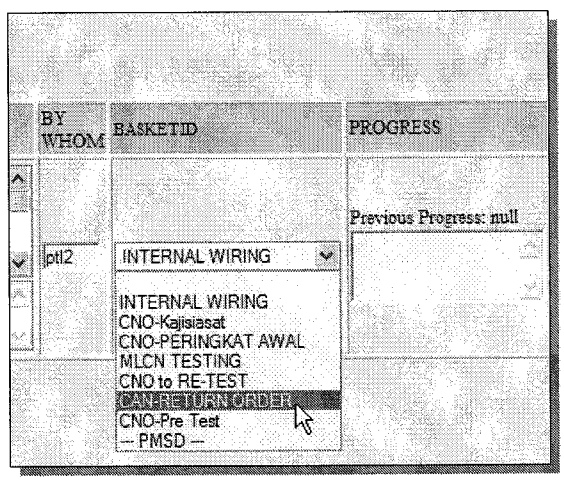


Figure 9 : Page-by-page view of the prototype

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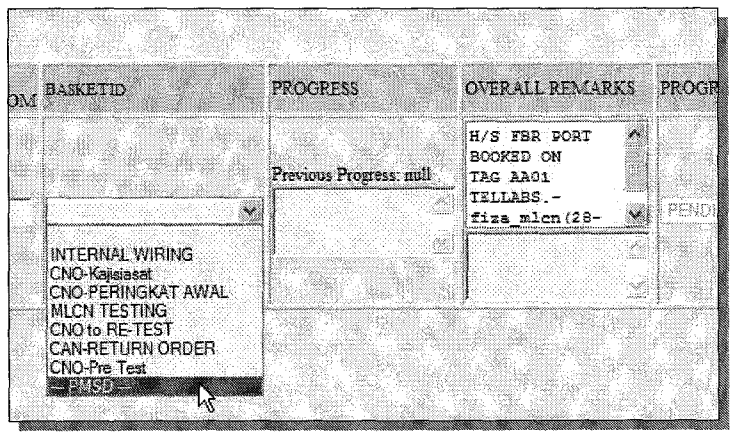


Figure 9 : Page-by-page view of the prototype

Appendix D

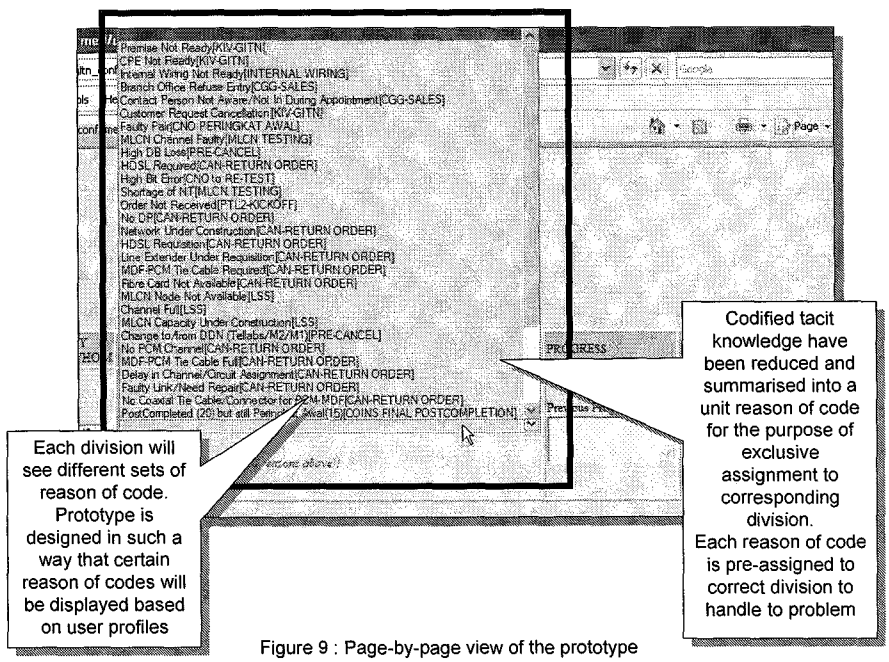


Figure 9 : Page-by-page view of the prototype

Appendix D

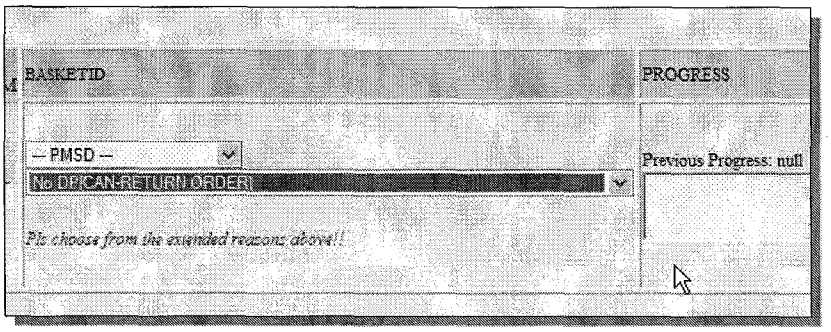


Figure 9 : Page-by-page view of the prototype

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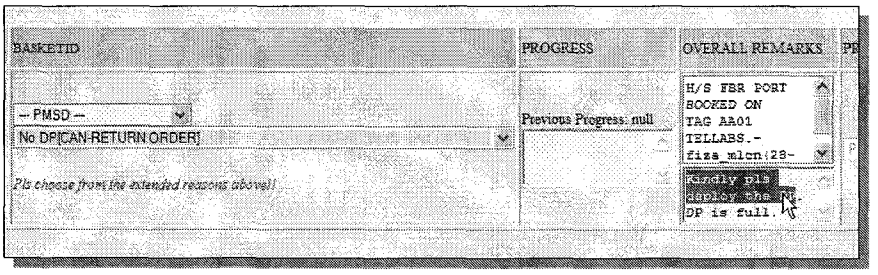


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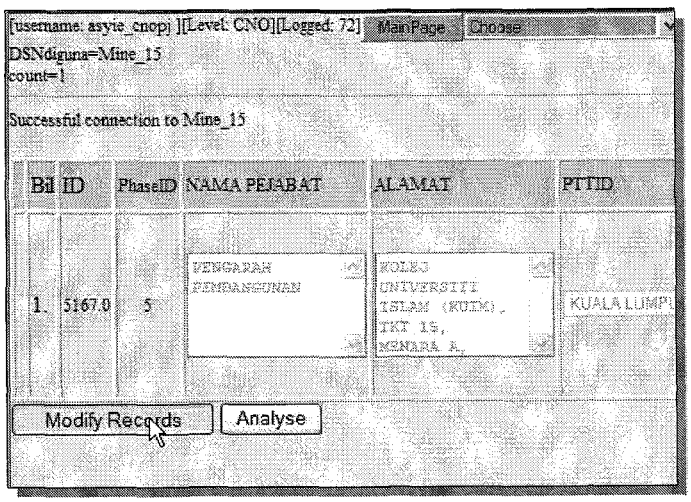


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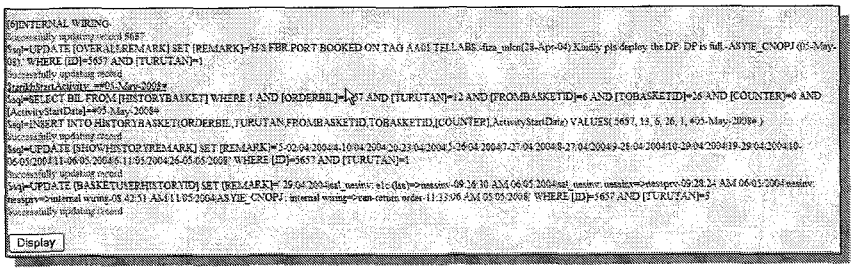


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